THE
WORLD BOOK
ENCYCLOPEDIA

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INSTITUTE OF EDUCATION FOR WOMEN
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THE

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Volume 5

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IN NINETEEN VOLUMES AND
READING AND STUDY GUIDE

FIELD ENTERPRISES EDUCATIONAL CORPORATION
Merchandise Mart Plaza · Chicago 54 · Illinois

THE WORLD BOOK ENCYCLOPEDIA

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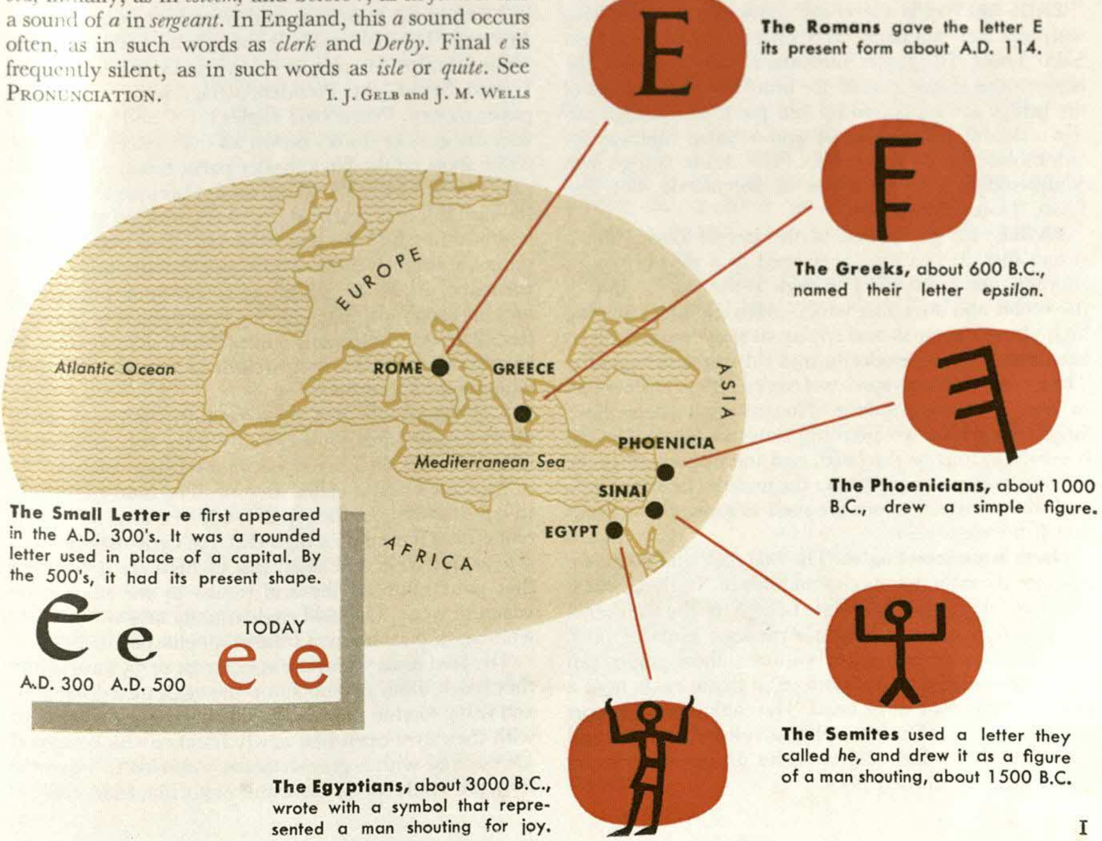
Ee is the fifth letter of our alphabet. It was also the fifth letter in the alphabet used by the Semites, who once lived in Syria and Palestine. The Semites named the letter *he*, and adapted an Egyptian *hieroglyphic*, or picture symbol, of a man rejoicing, perhaps because the sound of *he*, which resembles our *h*, began a shout of hallelujah. The ancient Greeks later gave the symbol the sound of *e* in *bed*. They called it *epsilon*. The Romans gave the capital *E* its present form. See ALPHABET.

Uses. *E* or *e* is the most frequently used letter in books, newspapers, and other printed material in English. On school report cards, *E* signifies *excellent*. It is also an abbreviation for *East*. In *EST*, it stands for *Eastern Standard Time*, and in *E.S.U.*, for *English-Speaking Union*. In music, *e* indicates the third tone in the major scale, as well as the note representing that tone on the staff. In measurements, *e* stands for *erg*, a unit of energy. It stands for *entrance* in stage directions.

Pronunciation. *E* or *e* has various distinct sounds. In English, a person pronounces the long *e* sound, as in *be*, with the highest part of his tongue well forward, toward the hard palate, and with his teeth and lips slightly parted. The other sounds of *e* include that in *bed;* initially, as in *esteem;* and before *r*, as in *fern*. *E* has a sound of *a* in *sergeant*. In England, this *a* sound occurs often, as in such words as *clerk* and *Derby*. Final *e* is frequently silent, as in such words as *isle* or *quite*. See PRONUNCIATION.

I. J. GELB and J. M. WELLS

The fifth letter took its shape from an ancient Egyptian symbol used to represent a man shouting for joy. Its sound came from a Semitic word or exclamation.



The Romans gave the letter E its present form about A.D. 114.

The Greeks, about 600 B.C., named their letter *epsilon.*

The Phoenicians, about 1000 B.C., drew a simple figure.

The Semites used a letter they called *he,* and drew it as a figure of a man shouting, about 1500 B.C.

The Egyptians, about 3000 B.C., wrote with a symbol that represented a man shouting for joy.

The Small Letter e first appeared in the A.D. 300's. It was a rounded letter used in place of a capital. By the 500's, it had its present shape.

$E=MC^2$ is the formula developed by the physicist Albert Einstein which laid the basis for the application of atomic energy. See ATOMIC ENERGY (Mass Into Energy).

E PLURIBUS UNUM, *ee PLOO rih bus YOO num,* is the Latin motto on the face of the Great Seal of the United States (see GREAT SEAL OF THE UNITED STATES). This phrase means *one out of many.* It refers to the creation of one nation, the United States, out of 13 colonies. It is equally appropriate to today's federal system. Benjamin Franklin, John Adams, and Thomas Jefferson, members of the first committee for the selection of the seal, suggested the motto in 1776. It can be traced back to Horace's *Epistles.* Since 1873, the law requires that this motto appear on one side of every United States coin that is minted. DONALD H. MUGRIDGE

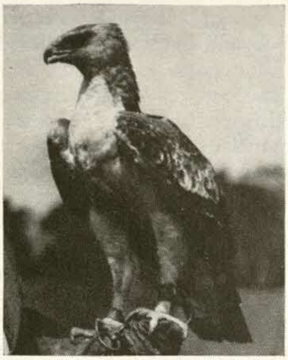
EADS, *eedz,* **JAMES BUCHANAN** (1820-1887), was an American engineer and inventor. He used willow-brush mattresses capped with stone to build the jetties at the mouth of the Mississippi River. They permitted large ocean-going ships to navigate the river (see JETTY). He also designed and built the steel-arch Eads Bridge in St. Louis (see EADS BRIDGE).

Eads was born in Lawrenceburg, Ind. He became a steamboat clerk in St. Louis, and invented a diving-bell boat and a device for raising sunken boats. He was considered an authority on navigating the Mississippi. President Abraham Lincoln asked for his advice during the Civil War. Eads designed and built the first gunboats armored with iron plates. They were used in capturing Fort Henry in 1862, and were the first armored warships. ROBERT W. ABBETT

EADS BRIDGE is a steel arch structure over the Mississippi River that connects Saint Louis, Mo., and East Saint Louis, Ill. James Buchanan Eads designed the bridge, and it was named for him. The three spans of the bridge are supported by four piers. The bridge carries a double railroad track, and a broad highway for automobiles and pedestrians. The Eads Bridge was completed in 1874 at a cost of $6,500,000. See also EADS, JAMES BUCHANAN.

EAGLE, *EE g'l,* is one of the largest birds, and a strong flier. It has long been used as a sign of power, courage, and freedom. The eagle is the poet's "bird of the broad and sweeping wing." Men picture it soaring high above the earth and spying its prey far off with its keen eyes. Not all eagles fit into this romantic picture. The several different species of eagles differ considerably in size, looks, and habits. However, all eagles have large, strong bills and powerful claws, or *talons.* The bill is nearly as long as the head, and the upper half of the bill curves down sharply over the lower. The strong toes and sharp, curved talons are used to grasp the animals which the eagle eats.

North American Eagles. The *bald eagle* and the *golden eagle* are the only two species that live in North America. They are about the same size. Except for the California condor, they are the largest American birds of prey. Like the condor and other vultures, these eagles can soar at great heights. You can tell a flying eagle from a vulture if you look at its head. The eagle's head is large and covered with feathers, while a vulture's is small and bare. The bald and golden eagles do not carry away small children to their nests.



Kaufmann & Fabry

The South African Hawk Eagle, above, is often used for falconry.

The Bald Eagle is also called the *bald-headed,* or *white-headed, eagle.* It has these names because the fully grown bird has a pure white head and neck. This eagle makes its home in the temperate and warmer regions of North America. The bald eagle is the official emblem of the United States. Its picture is on the Great Seal of the United States, the President's flag, some coins, and paper money. When bald eagles are 1 and 2 years old they are gray or smoky brown all over, except for a few white spots on the back, under parts, head, wings, and tail. The head, neck, and tail do not become white until the bird is 3 or 4 years old. Feathers grow on the legs to within an inch of the toes. The bill, feet, and bare leg parts are bright yellow. Males and females are colored the same. Males are about 35 inches long and weigh around 8 pounds. They have a wingspread of about 7 feet. Females are usually larger. Their length may be as great as 42 inches, their weight 12 pounds, and their wingspread about 8 feet.

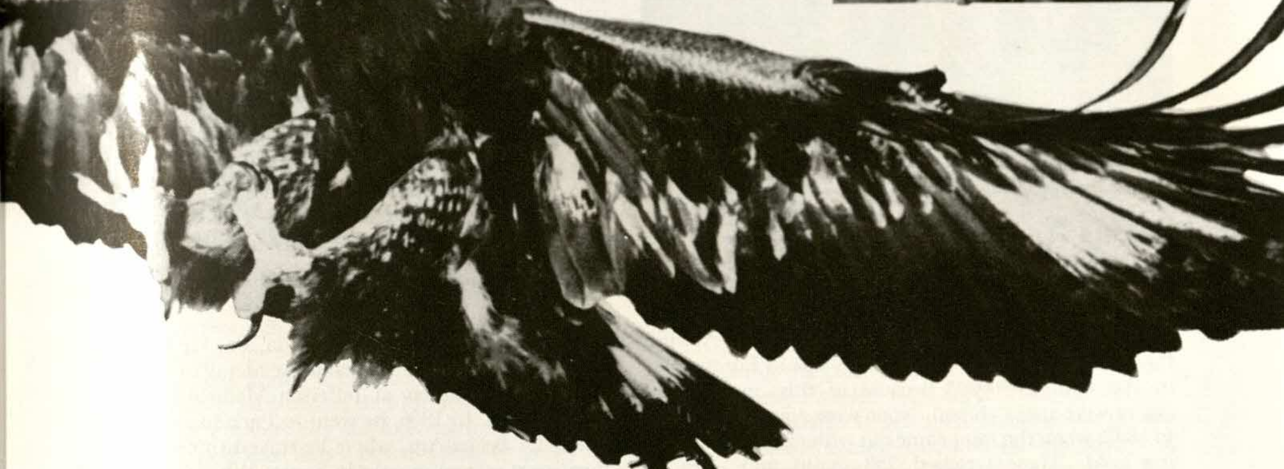
The bald eagle eats meat, many small mammals, reptiles, and birds. It especially likes fish, and often robs the bird called the osprey of the fish it catches.

An eagle's nest is called an *eyrie.* The bald eagle likes to build its eyrie in the top of a tall tree near the water. Sometimes it nests on a high cliff. An eyrie may be from 5 to 8 feet wide and often just as high. It is believed that pairs mate for life and return to the same eyrie year after year. The bald eagle usually lays two or three white eggs that are soon stained a yellowish color.

The bird must warm the eggs for 34 or 35 days before they hatch. Both parents sit on the eggs, guard the nest, and bring food to the young. The baby eaglets are born with their eyes open like newly hatched chickens, and are covered with a grayish down. After 10 to 13 weeks they are ready to fly from the nest. The bald eagle is

The American Bald Eagle has a snowy white head that looks bald when viewed from a distance. It is the official U.S. emblem.

Gendreau



The American Golden Eagle makes pinpoint landings from great heights. With its broad tail and enormous 7-foot wings braced, the bird can maneuver its body so accurately it can land without a runway. Strong breast muscles supply braking power.

David Goodnow for *Sports Illustrated*

rare in the United States, because it has been hunted so much. Federal laws now protect it fully in the United States.

The Golden Eagle lives in lonely mountainous regions of North America, Europe, northern Asia, and northern Africa. It is also called the *mountain eagle*, and in some places *ring-tailed eagle*. The young birds appear ringed from the white in the upper part of their tails. They also have whitish marks scattered over them, but all the white disappears as they get older. The body feathers of the adult are dark brown, while the top of the head and back of the neck are golden brown. The bill is bluish-black with a yellow fleshy part at the base. The legs of this bird, unlike the bald eagle's, have feathers down to the toes. The golden eagle is inclined to soar more and flap its wings less than the bald eagle. Its flight is also considered more graceful. Golden eagles eat mostly mammals, such as rabbits, fawns, and sometimes a young lamb. They also catch different birds, including waterfowl. Their favorite nesting place is a rocky shelf on some steep mountainside, but sometimes they choose a tall tree. The nest is enormous. One nest took two wagonloads of material to build. It was 7 feet high and 6 feet wide on top. Two or three eggs are usually laid at a time. They are whitish, spotted with brown. In western North America this bird has the name *war eagle*, because the Indians preferred its wing and tail feathers for their war bonnets.

The Eagle as a Standard. The Romans used a golden figure of an eagle to stand for strength, skill, and bravery. They placed it on the tip of a spear and carried it as a standard at the head of a legion. They used figures of other animals, too, but in 104 B.C. the eagle became their chief emblem. After the 1200's the favorite designs on the shields of knights and noblemen were first the lion, and then the eagle. The German emperors also chose the eagle, as the Roman Caesars had. A double-headed eagle was on the imperial Russian and Austrian coats-of-arms. The black eagle was also the emblem of Prussia. An important decoration was named for it.

In 1787, the newly formed United States took as its emblem a bald eagle with outspread wings, a shield on its breast, an olive branch in one foot, and a sheaf of arrows in the other. The eagle on the American coat-of-arms carries a scroll in its beak bearing the Latin words, *E Pluribus Unum*, meaning *one out of many* (see UNITED STATES, GOVERNMENT OF [color picture]). The first eagle on an American coin appeared on a Massachusetts penny in 1776.

Other Eagles. The following table gives the names of some of the other eagles, and also tells where they live.

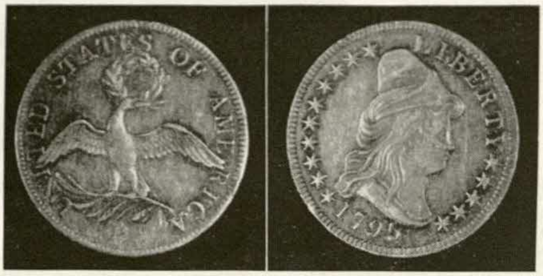
Name	Home
White-tailed eagle	Northern regions of Europe and Asia, Greenland, Iceland, occasionally North America
Steller's sea eagle	Northeastern Siberia, occasionally Alaska
Harpy eagle	Central and South America
Hawk eagle	Central and South America
Monkey-eating eagle	Philippine Islands
Fishing eagle	Southern Asia, Malaya, East Indies
Wedge-tailed eagle	Australia
African crested eagle	Africa

Scientific Classification. Eagles are members of the family *Accipitridae*. The bald eagle is classified as genus *Haliaeetus*, species *leucocephalus*. The golden eagle is *Aquila chrysaëtos*.

OLIN SEWALL PETTINGILL, JR.

Related Articles in WORLD BOOK include:

- Bald Eagle
- Bird (color picture, Hunters of the Sky)
- Condor
- E Pluribus Unum
- Harpy
- Lammergeier



Chase Manhattan Bank Money Museum

The United States Gold Eagle had a value of $10.00. It was first minted in 1795 and showed an eagle holding a laurel wreath. The eagle was nine-tenths pure gold after 1838.

EAGLE was the popular name for a ten-dollar gold coin minted in the United States from 1795 to 1934. It was one of three coins named in the first act of Congress to authorize coinage, in 1792. For many years it was the most valuable United States coin. At first, the coins had a higher purchasing value in Europe than in the United States. Because of this, most of the eagles were spent abroad. None were coined from 1804 to 1838, when the mint came out with eagles containing less gold. These weighed 258 grains and were $\frac{9}{10}$ pure gold. They were used widely in the United States until 1934, along with double-eagles, half-eagles, and quarter-eagles. SAWYER McA. MOSSER

See also MONEY (United States Coins).

EAGLES, FRATERNAL ORDER OF, is a benefit-paying fraternal organization with headquarters at 2401 W. Wisconsin Ave., Milwaukee, Wis. It has about 800,000 members in 1,557 chapters, or *Aeries*, in the United States, Canada, and the Philippines. Women are never actually members of the order, but they have auxiliary chapters. Membership dues pay for such services as medical, sick, and funeral benefits. The order actively promotes state old-age pensions, social security legislation, Mother's Day observances, and job opportunities for older workers. In cooperation with CARE, it founded *Eaglehaus*, a vocational training school for young people in West Berlin, Germany. It founded similar schools in Valdivia, Chile; Naples and Catania, Italy; Mexico City; and Manila, P.I. Aeries promote safety campaigns and other civic activities. The order was founded in Seattle, Wash., in 1898. Its motto is *Liberty, Truth, Justice, and Equality.* See also FRATERNAL SOCIETY. ARTHUR S. EHRMANN

Fraternal Order of Eagles.

EAKER, *AY kur,* **IRA CLARENCE** (1896-), an American military leader, entered the United States Army as an infantry officer in 1917. But he soon transferred to the Air Service. He became one of the outstanding pilots of the Army Air Corps after World War I, and took part in several important experimental flights. In 1942, he took charge of the U.S. Bomber Command in Europe, whose B-17's began the strategic bombing of Germany. Later, he was promoted to lieutenant general, and became commanding general of the Mediterranean Allied Air Forces. From 1945 to 1947, he served as deputy commander and chief of staff for the Army Air Forces. Eaker was born in Llano County, Texas, on April 13, 1896. WESLEY FRANK CRAVEN

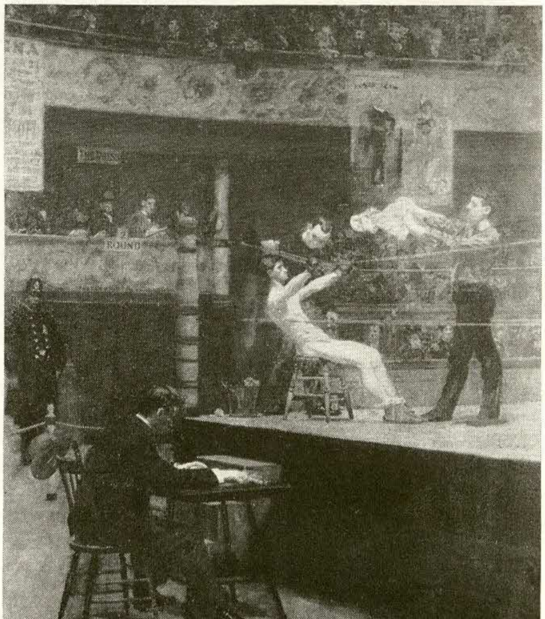
EAKINS, *AY kinz,* **THOMAS** (1844-1916), was one of the greatest American realist painters of the 1800's. He painted portraits and many scenes of outdoor life and sporting events, such as swimming, sculling, hunting, and prize fighting. Eakins brought great vitality and deep human insight to his art. He tried to achieve scientific accuracy and painstaking detail without losing feeling. The colors are fairly dark in his indoor paintings and portraits, but he captured the subtle effects of light and atmosphere in his outdoor scenes.

His most famous portraits include *Walt Whitman, The Thinker*, and two group portraits, *The Clinic of Dr. Gross* and *The Clinic of Dr. Agnew*. Among his famous outdoor paintings is *Max Schmitt in a Single Scull*, which appears in color in the PAINTING article.

Eakins was born in Philadelphia, Pa. He began his art training at the Pennsylvania Academy of Fine Arts, and studied anatomy at Jefferson Medical College in Philadelphia. In 1866, he went to Paris to study at the École des Beaux-Arts, where he stayed three years. He then spent several months in Spain. When he returned to the United States in 1870, he established himself as a portrait painter in Philadelphia. He painted portraits of members of his family and of his friends, mostly musicians and doctors. But he gained no public or critical acceptance. He taught at the Philadelphia Academy and lectured on anatomy at various other art schools. He was also a sculptor. MILTON W. BROWN

Thomas Eakins' portrait, *right*, is a detail of a painting by his wife. *Between Rounds, below*, shows how this American artist emphasized realistic detail in his paintings.

Philadelphia Museum of Art



EAR is man's second most important sense organ. Only our eyes are more important to us. Our ears enable us to hear. They also give us our sense of balance. We would find it hard even to stand if certain parts of our ears were damaged.

Hearing lets us exchange ideas and opinions with other persons through speech. It also gives us pleasure. Through our ears, we enjoy the beauty of music and the sound of a loved one's voice. Hearing protects us, too. We hear the warning blast of an automobile horn, or the clang of a fire bell.

This article tells about the parts of the ear and how they work. For a discussion of sound and how it is produced, see SOUND.

Care of the Ear

The ear is a delicate organ, easily damaged by infection or injury. Serious damage to the ears can make a person partly or completely deaf. Ear injury can also cause a loss of the sense of balance. Doctors always inspect the ears during a physical examination. They use an *otoscope*, an instrument with a battery-powered light at the tip that can be inserted in the ear (see OTOSCOPE). A doctor tests a person's hearing by speaking to him or by sounding a tuning fork. He may also use an *audiometer*, an electrical device that measures the patient's response to various tones.

The ability to hear changes as a person grows older. A baby cannot hear at all during the first few days after birth. During the first 25 years of life, the ability to hear low tones increases. After the age of 50, a person may not be able to hear high tones as well as before. Some persons begin to lose this ability as early as 25. The loss occurs slowly but progressively. See SOUND (Hearing Sound; Characteristics of Sound).

For information about the various causes of deafness and how deafness is treated, see DEAFNESS.

Preventing Ear Infections. Infections in the nose and throat spread easily. Blowing your nose properly helps keep infections from reaching the ears. Never pinch the nostrils shut when blowing your nose. If you blow your nose with the nostrils shut, germs may be forced back into the ears.

Infections can also enter the ears while you are swimming or diving. Wear ear plugs in the water to avoid getting germs in your ears.

Infections of the ears and other parts of the body often cause painful earaches. For example, *mastoiditis*, a serious infection of the bone cells near the ear, often causes an earache. So do middle-ear infections, inflammation of the Eustachian tube, and, occasionally, wax lodged against the eardrum. See a doctor when you have a severe earache, especially when it is accompanied by a fever.

Preventing Ear Injury. Never strike another person on the ear, particularly with the palm of the hand. Such a blow may force air into the ear canal and break the eardrum. It can also cause a deformity of the ear lobe called *cauliflower ear*. Many boxers have this deformity, because they receive repeated blows to the head.

Doctors often warn: "Never put anything smaller than your elbow into your ear." This is sound advice, because any object put into the ear may cause serious harm. Never stick matches, hairpins, peas, beans, or other small objects into your ear. They may break the skin, causing infection and pain. Small insects sometimes get into the ear. Never try to get anything out of your ear. Ask a doctor to do it.

Large amounts of wax sometimes accumulate in the ear. Wax is a normal secretion of glands in the skin of the ear canal. A person may push wax farther into the ear if he tries to remove it. This may injure the ear canal and even damage the eardrum. Plugs of wax should be removed only by a doctor. He uses an ear syringe to shoot a stream of moderately warm water into the ear canal. He aims the water at the side of the canal, so that the pressure washes out the wax but does not hit the eardrum with too much force.

Loud sounds can also harm the ear, and may cause loss of hearing. Ear plugs can protect the ears from extremely loud noises.

Parts of the Ear

The part of the body that we usually call the "ear" is only a portion of this vital organ. The ear extends deep into the skull. It has three main parts: (1) the outer ear, (2) the middle ear, and (3) the inner ear. Each plays a special part in hearing.

The Outer Ear has two important parts: (1) the *auricle*, which is the fleshy curved part attached to the side of the head, and (2) an opening called the *external auditory canal*.

The Auricle has a cuplike shape that enables it to collect sound waves and direct them into the external auditory canal. The auricle is composed of fatty tissue and *cartilage*, a tissue that is softer than bone but harder than muscle. A layer of skin covers the entire structure. A few weak, poorly developed muscles are attached to the auricle. These muscles have no function, but some persons can use them to wiggle their ears. Some animals, including horses, dogs, cats, and rabbits, have well-developed auricle muscles. These muscles enable the animals to move their ears around to gather sounds more efficiently.

The External Auditory Canal is the opening you see if you look directly into the ear. This passageway is about 1½ inches long. It guides sound waves from the auricle to the middle ear. The outer third of the canal is lined with fine hairs and with the tiny glands that produce wax. The hairs and wax trap dust, insects, and other small particles. This keeps them from causing possible injury deep in the canal.

The Middle Ear, or *tympanic cavity*, resembles a box with six sides. The *eardrum*, or *tympanic membrane*, a thin sheet of tissue a little more than ¼ inch across, separates it from the external auditory canal. At the other end, a thin wall of bone separates the middle ear from the inner ear. Three small, movable bones are linked to each other inside the tympanic cavity. These bones are called the *auditory ossicles*. The outermost bone, the *malleus*, or *hammer*, is attached to the eardrum. The middle bone, called the *incus*, or *anvil*, connects the malleus and the innermost bone, the *stapes*, or *stirrup*. The stapes attaches to the inner ear. These bones are similar in shape to the objects for which they are named. Sound waves pass from the external auditory canal, through the eardrum, across the three bones (the malleus, incus, and stapes), then to the inner ear.

Two parts of the head connect to the middle ear but are not part of it. The *mastoid process* is a series of small, air-filled spaces in the bones that lie behind the auricle. These spaces connect with the tympanic cavity. The *Eustachian tube*, or *auditory tube*, is about 1½ inches long and connects the back of the nose with the middle ear. It allows air to pass from the nose to the tympanic cavity. This maintains equal air pressure on both sides of the eardrum and prevents the drum from breaking due to changes in pressure. See EUSTACHIAN TUBE.

The Inner Ear has so many intricate chambers and passageways that it is called a labyrinth (see LABYRINTH). The inner ear is formed partly within the temporal bone of the skull. It consists of a *bony labyrinth* that contains a narrower *membranous labyrinth*. A fluid called *perilymph* separates the bony labyrinth from the membranous labyrinth. The membranous labyrinth itself is filled with a fluid called *endolymph*.

The inner ear has three connected parts: (1) the vestibule, (2) the semicircular canals, and (3) the cochlea. The *vestibule* is the central part of the inner ear. One side of it connects with the middle ear. Above and behind the vestibule are the three *semicircular canals*, which give us our sense of balance. In front of the vestibule is the *cochlea*, which looks like a snail shell. It contains the sense organ for hearing, the *organ of Corti*.

How We Hear

A sound wave is a vibration in the air. The structure of the ear enables sound vibrations to pass from outside the head to the part of the brain that controls hearing.

How Sound Reaches the Inner Ear. For a person to hear, the vibrations must reach the organ of Corti. Sound waves can reach the inner ear by three different routes.

First, in the most important way of hearing, sound waves cause the eardrum to vibrate. The vibrations of the eardrum are carried across the middle ear by the auditory ossicles to the *oval window*, an opening between the middle and inner ears. Sound vibrations cause the footplate of the bone called the stapes to move like a plunger in and out of the oval window. This causes the fluid in the cochlea to move.

The second way that sound waves reach the inner ear is by traveling through air from the eardrum to the *secondary eardrum*, a membrane that covers the round window. The *round window* is an opening in the middle ear located below the oval window. Sometimes, as a result of injury or disease, a hole forms in the eardrum. This condition, called *ruptured eardrum*, usually does not interfere with hearing. Sound waves pass through this hole to the secondary eardrum. The vibrations of the membrane of the secondary eardrum are carried to the perilymph.

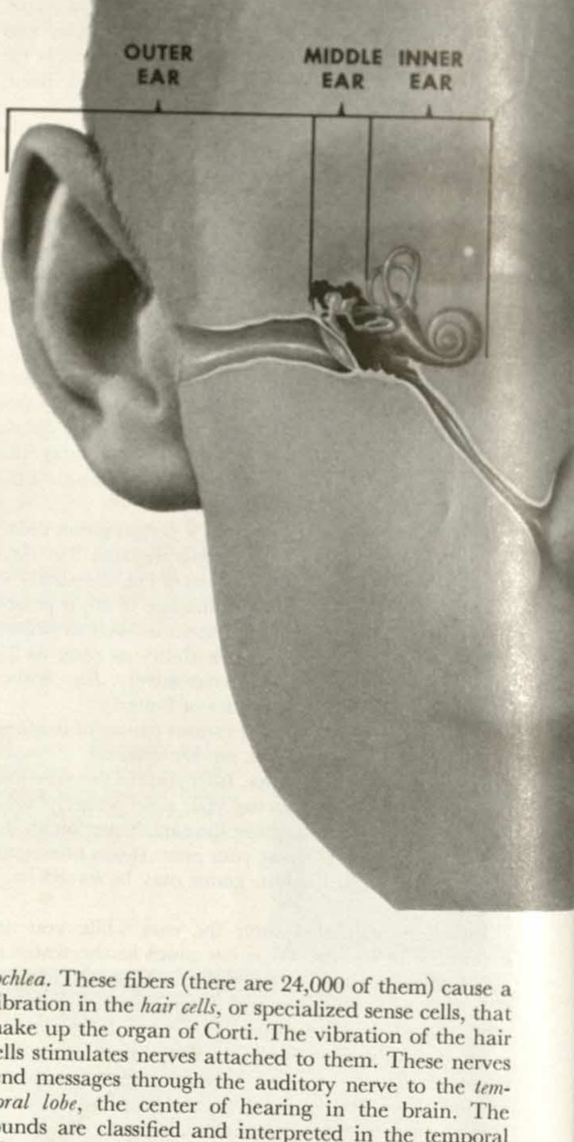
In the third way, sound waves travel directly through the bones of the skull. These bones send the sound vibrations to the inner ear. Some hearing aids are based on this method of carrying sound waves (see HEARING AIDS [Types of Hearing Aids]).

The Inner Ear Sends Sounds to the Brain. When sound waves move through the perilymph, they move the fibers of the *basilar membrane*, which lies within the *cochlea*. These fibers (there are 24,000 of them) cause a vibration in the *hair cells*, or specialized sense cells, that make up the organ of Corti. The vibration of the hair cells stimulates nerves attached to them. These nerves send messages through the auditory nerve to the *temporal lobe*, the center of hearing in the brain. The sounds are classified and interpreted in the temporal lobe. See BRAIN (The Cerebrum).

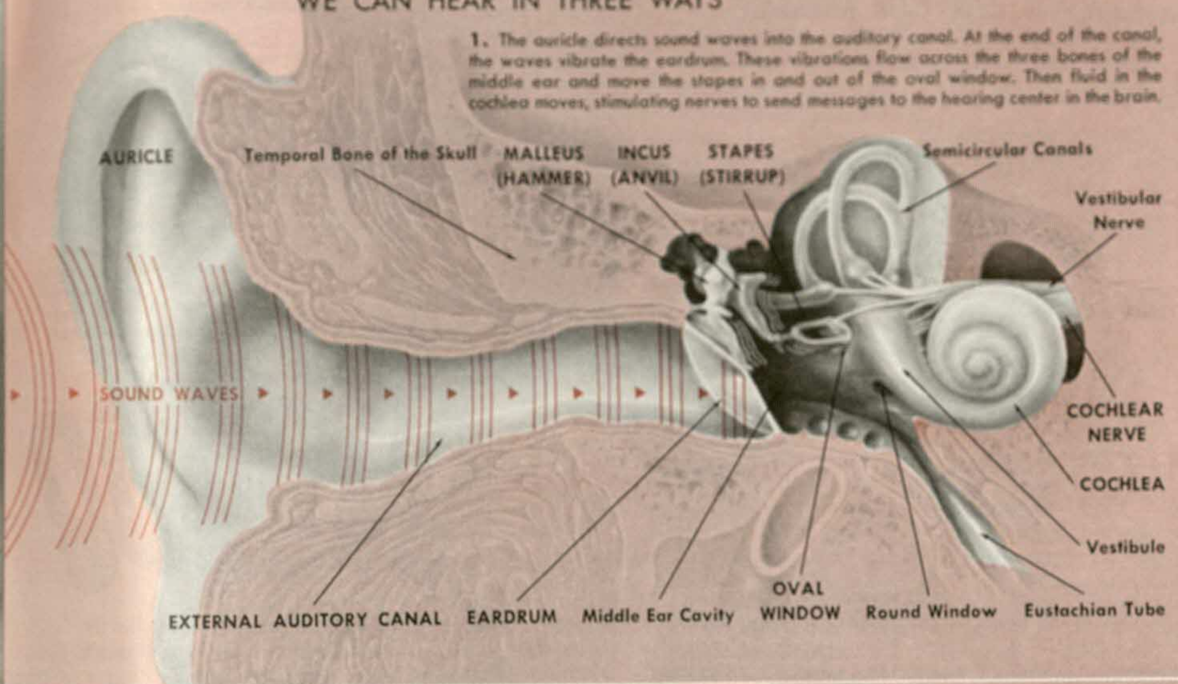
Scientists do not know exactly how the hearing mechanism of the body tells the difference between sounds of different pitch (see SOUND [Pitch]). The *resonance theory* says that the cochlea tells the difference between sounds of different pitches. The fibers of the basilar membrane vary in length, like the strings of a piano. Because the fibers vary in length, they are set into sympathetic vibration by different frequencies (see SOUND [Resonance; Sympathetic Vibrations]). The shortest fibers, located at the base of the cochlea, respond to high-pitched sounds. The longest fibers, at the end of the cochlea, respond to low-pitched sounds.

PARTS OF THE EAR

The main parts of the human ear are shown below in life-size. We normally see only the *auricle*, or outer ear that collects sound waves. The tiny parts of the ear that actually hear sound lie deep inside the head.

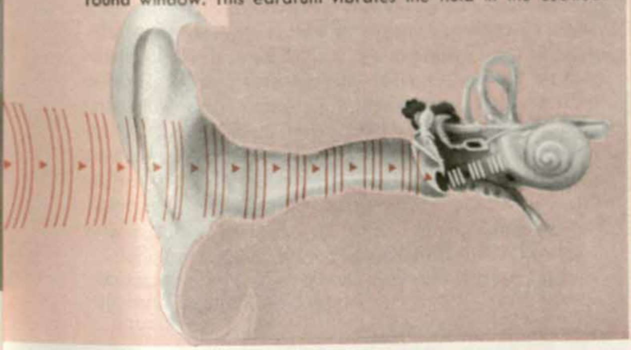


WE CAN HEAR IN THREE WAYS

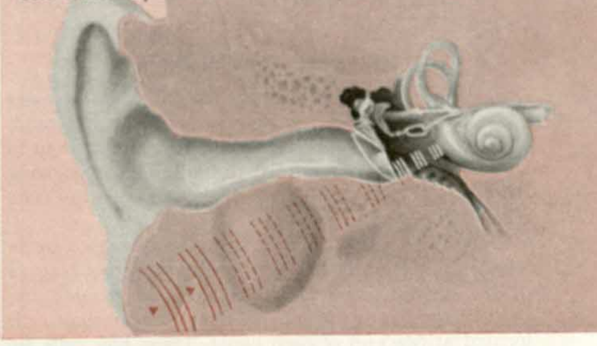


1. The auricle directs sound waves into the auditory canal. At the end of the canal, the waves vibrate the eardrum. These vibrations flow across the three bones of the middle ear and move the stapes in and out of the oval window. Then fluid in the cochlea moves, stimulating nerves to send messages to the hearing center in the brain.

2. Sound may pass through air from the eardrum, or through a hole in the eardrum, to the secondary eardrum, which covers the round window. This eardrum vibrates the fluid in the cochlea.

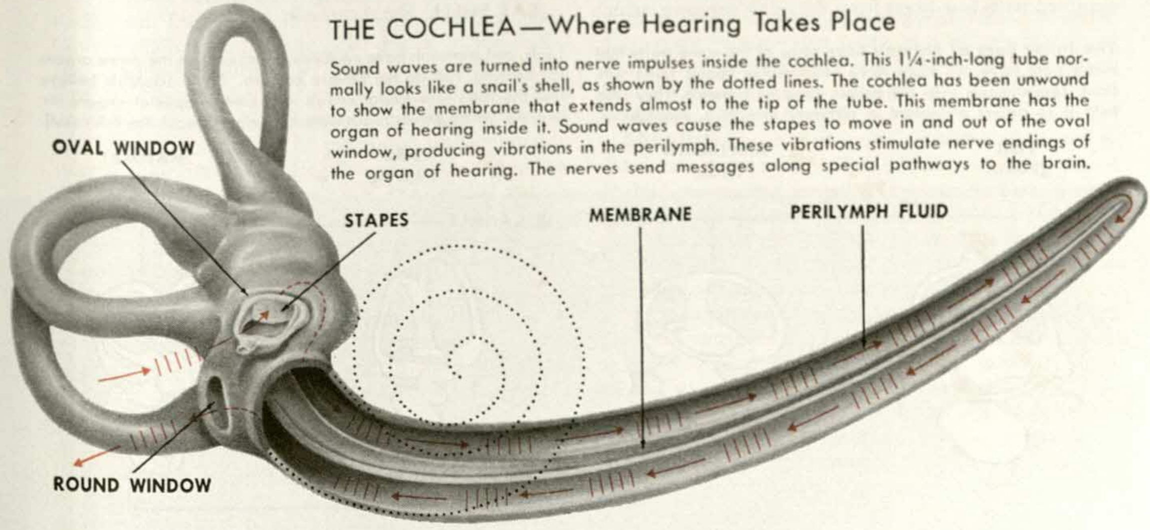


3. The bones of the skull that surround the ear can carry sound waves. The waves pass through the bones directly to the inner ear. When they strike the cochlea, they cause its fluid to move.



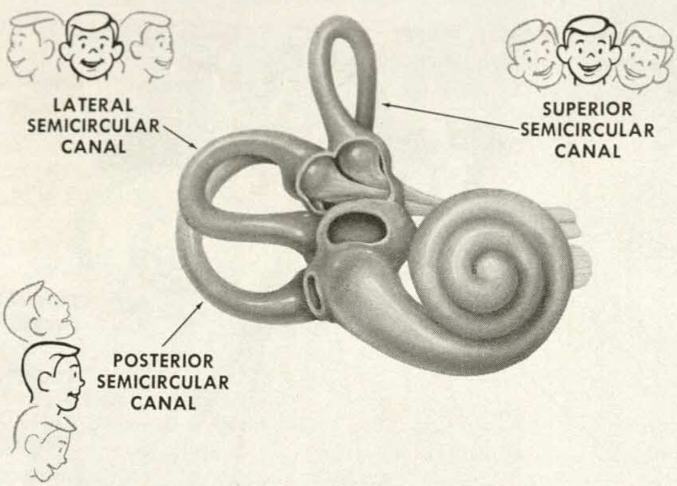
THE COCHLEA—Where Hearing Takes Place

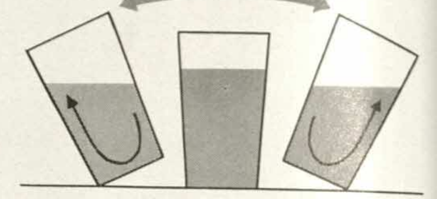
Sound waves are turned into nerve impulses inside the cochlea. This 1¼-inch-long tube normally looks like a snail's shell, as shown by the dotted lines. The cochlea has been unwound to show the membrane that extends almost to the tip of the tube. This membrane has the organ of hearing inside it. Sound waves cause the stapes to move in and out of the oval window, producing vibrations in the perilymph. These vibrations stimulate nerve endings of the organ of hearing. The nerves send messages along special pathways to the brain.



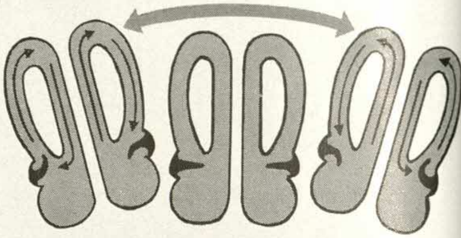
HOW WE KEEP OUR BALANCE

The semicircular canals of the inner ear are concerned only with our sense of balance. They do not help us hear. The boys' heads show how each canal detects movement in a different direction. Nerves carry messages from the canals to the brain, which relays the messages to the muscles we use to keep our balance.


LATERAL SEMICIRCULAR CANAL
SUPERIOR SEMICIRCULAR CANAL
POSTERIOR SEMICIRCULAR CANAL



When we move, fluid in the semicircular canals also moves to keep its position, much as water moves when you tilt a glass, *above*. Motion causes changes in pressure in the canals, *below*. Nerves alert the brain to the changes, and it sends messages to the muscles, which act to maintain balance.



According to another theory, the *telephone theory*, the ear works like a telephone. Sound waves that strike the eardrum (which corresponds to a telephone transmitter) set up nerve impulses (which correspond to electrical impulses in a telephone wire) of exactly the same frequency as the original sound. The nerve impulses go to the brain, which discriminates sounds of different frequencies (pitch).

How the Ear Gives Us Balance

The three fluid-filled semicircular canals in the inner ear enable us to keep our balance when we sit, stand, walk, run, or ride a bicycle. These canals enable us to recognize the direction in which our bodies are moving—forward or backward, up or down, or sideways—even when our eyes are closed.

One of them is horizontal, and the other two are in a vertical position. When the head or body moves up or down, forward or backward, or from side to side, the fluid in the canals moves, affecting delicate hair cells located at one end of each canal. These hair cells are supplied with fine fibers from the *vestibular nerve*, which carries impulses to the brain. The brain immediately interprets the impulses as changes in the body's position. Then the brain sends "messages" to the various muscles of the neck, trunk, and limbs that maintain the balance of the body.

Dizziness and trouble in balancing occur when the semicircular canals become diseased. If the semicircular canals are destroyed, the body loses its ability to maintain balance, or *equilibrium*. This happens because the brain has lost an important source of information and cannot direct the muscles that keep the head and other parts of the body in balance. Seasickness and the dizziness produced by swinging or turning around rapidly result from excessive stimulation of the semicircular canals in one direction. See DIZZINESS; SEASICKNESS.

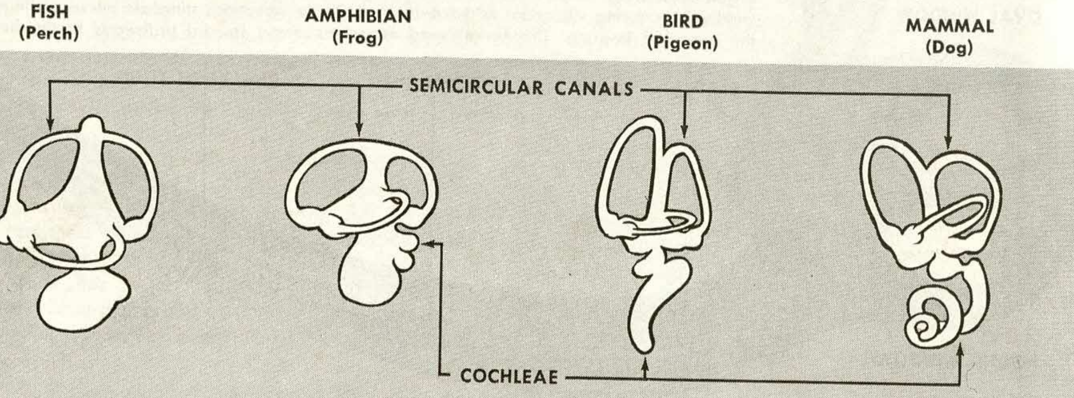
NOAH D. FABRICANT

Related Articles in WORLD BOOK include:

Animal (Animal Sense Organs; picture, Unusual Ears)
Deaf-Mute
Deafness
Eustachian Tube
Hearing Aids
Mastoid
Otoscope
Sound

EAR SHELL. See ABALONE.

The Inner Ears of Animals have some of the same parts that man's ears have. All have three semicircular canals filled with fluid. These canals help the animal keep its balance. They also help it to detect movement in different directions. Amphibians, birds, and mammals have *cochleae*, which contain the sense organs for hearing. Fish do not have a cochlea. Some scientists believe that the fish's semicircular canals may contain special organs for hearing. Sound waves reach them by going through the fish's skull.



EARHART, AMELIA (1898-1937), became the first woman to cross the Atlantic Ocean by air and the first woman to fly it alone. She was also the first woman to receive the Distinguished Flying Cross.

Kansas State Historical Society, Topeka

Amelia Earhart

Miss Earhart was born at Atchison, Kans. She studied at Columbia University after nursing wounded soldiers during World War I. But she dropped out of school and worked in California to earn money for flying lessons. She worked briefly in Boston as a social worker.

In 1928, Miss Earhart became the first female passenger on a transatlantic flight. She flew from Newfoundland to Burry Port, Wales. She wrote a book about this experience, and later married her publisher, George Putnam. In 1932, Miss Earhart flew the Atlantic alone, from Harbor Grace, Newfoundland, to Ireland. She was the first woman to fly from Honolulu to the mainland of the United States and the first to fly across the United States alone in both directions. She lost her life during a nearly successful attempt to fly around the world. Her airplane vanished at sea near Howland Island in the Pacific Ocean. Robert B. Hotz

EARL, *url,* is the oldest title of nobility in the British peerage. It was also the highest title until the Black Prince was made Duke of Cornwall in 1337. Later it became third in rank, with duke and marquis above it. An earl's wife is a countess.

See also Nobility; Title of Honor.

EARL, RALPH (1751-1801), was a self-taught Connecticut painter. His early portrait, *Roger Sherman,* in the Yale University Art Gallery is harsh, severe, and powerful, like the man himself. His double portrait of *Chief Justice and Mrs. Oliver Ellsworth* in the Wadsworth Atheneum at Hartford, Conn., is simple and direct. Recent appreciation of Earl's style has raised him from the status of a regional painter to one of national importance. He was born in Leicester, Mass. John D. Morse

EARLHAM COLLEGE is a coeducational school at Richmond, Ind., controlled by the Society of Friends. Courses offered lead to the A.B. degree in the liberal arts. Earlham College also offers a master's degree. Earlham became the first college in the United States to establish a speech department and an independent soils research program. The institution was founded in 1847 as the Friends Boarding School, and was reorganized as Earlham College in 1859. For enrollment, see Universities and Colleges (table).

EARLY, JUBAL ANDERSON (1816-1894), was a Confederate general in the Civil War. He opposed secession, but when Virginia seceded, he joined the Confederate Army, and became a lieutenant general. He fought at the first battle of Bull Run (Manassas), Antietam (Sharpsburg), Fredericksburg, and in the Chancellorsville campaign. He commanded a brigade and division in the Army of Northern Virginia.

General Robert E. Lee detached Early's corps in June, 1864, to threaten Washington, D.C. Early led this campaign with boldness and skill. He bombarded the outskirts of the Union capital in July, 1864, but was not strong enough to take the city. He retreated to the Shenandoah Valley and tried to delay the advance of the federal cavalry under General Philip H. Sheridan. Sheridan defeated Early decisively in March, 1865.

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Jubal A. Early

Early was born in Franklin County, Virginia, and was graduated from the United States Military Academy in 1837. He then studied law, and practiced at Rocky Mount, Va. He served in the Seminole and Mexican wars. After the Civil War, Early resumed his law practice. Although an "unreconstructed" rebel, Early was never popular in the postwar South. Frank E. Vandiver

EARLY CIVILIZATION. See Ancient Civilization.

EARLY MAN. See Prehistoric Man.

EARNEST MONEY. See House (Buying a House).

EARP, WYATT BERRY STAPP (1848-1929), was a frontiersman and peace officer in the American West. In 1879, he went to the booming silver camp of Tombstone, Ariz., and became a deputy sheriff of Pima County. Later, he also served as a deputy United States marshal, and rode stagecoaches to guard express shipments. At Tombstone in 1881, he and two of his brothers took part in the famous battle of the O.K. Corral.

Montgomery Foto Service

Wyatt Earp

Earp was born at Monmouth, Ill., and grew up in Iowa. He became a stagecoach driver, a railroad construction hand, and a surveyor. In 1869, he went to Springfield, Mo., and joined a government surveying party as a buffalo hunter on the Kansas plains. From there, he went to Wichita and Dodge City as a deputy marshal. Wayne Gard

See also Dodge City.

EARRING is one of the oldest ornaments known to mankind. Women have always loved precious gems set in gold, silver, or platinum. Costume jewelry earrings are set with semiprecious and imitation stones and other less expensive materials. Such earrings are popular because of their original designs and good craftsmanship, as well as their low cost.

Early peoples used pieces of stone, bone, and shell for their earrings. They often pierced their ear lobes to attach the ornaments. Many women today still have their ears pierced, because they consider that this method is the most comfortable one for wearing earrings, and prevents their loss. George R. Frankovich

See also Jewelry (pictures).

EARTH

We are all passengers on a great, round "space ship" called the planet Earth. We see our earth in many different ways, depending on where we live.

EARTH. The earth on which we live is called a *planet*. It is one of a family of nine planets that travel around our sun, together with many smaller balls and chunks. Our earth is only the tiniest of specks compared with the entire universe. The universe is made up of all the stars and all the other heavenly bodies. These seem to go endlessly out into space in every direction.

It helps us understand how small the earth really is when we know that about one million earths could be packed like tiny marbles into a hollow ball the size of our sun. And some of the stars, which are really other suns, are so big that *a million times a million* earths could easily fit inside them.

Some day, people may travel through space to other worlds. Then they can look at our earth from a distance and see it as it really is. They will see a smooth ball that slowly spins like a top as it travels around the sun.

In this article, you will read about the earth as a ball of air, rock, and water that moves through space in response to natural forces. For the world as the home of man, see WORLD.

The Earth Is a Traveler

It seems to us that the earth stands still. But that is because we are *on* the earth and cannot see or feel what is really happening.

The earth has three different motions. First, it spins around and around like a top. Second, it whirls around the sun. Third, it rushes through space with the sun and its sister planets.

The Earth Rotates, Making Day and Night. The spinning of the earth is called *rotation*. The earth spins so fast that its "waist," called the equator, goes at a speed of about 1,000 miles per hour. The top and bottom of the earth, which we call North and South Poles, are something like the point on which a top spins. They simply turn around, about once every 24 hours. An imaginary line drawn between the poles is called the earth's *axis*. We say that the earth turns, or rotates, on its axis. The exact time the earth takes to spin around once is 23 hours, 56 minutes, 4.1 seconds.

It is the spinning of the earth that makes our days and nights. We have night when the place where we happen to be turns out of reach of the sun's rays. The earth spins toward the east. This makes the sun seem to

WARM LANDS AND SEAS

HOT, DRY LANDS

HILLS AND MOUNTAINS

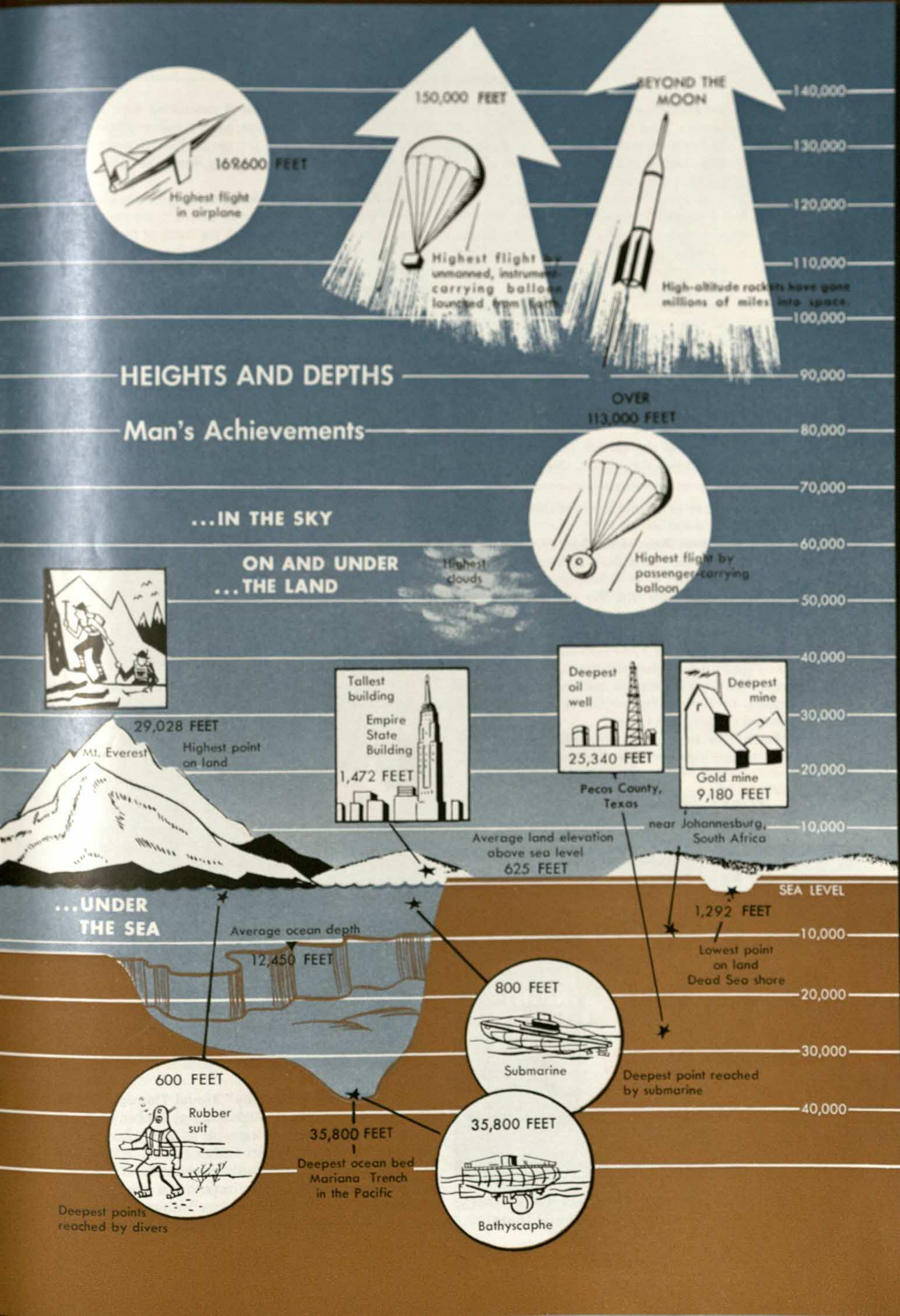
PRAIRIES AND PLAINS

Werner Stoy, Camera Hawaii; Ewing Galloway; Black Star

SWAMPS

HEIGHTS AND DEPTHS

Man's Achievements



THE EARTH AT A GLANCE

How Old Is the Earth? Geologists say that the earth is about 4,500,000,000 (four and one-half billion) years old. They get this figure from their study of the uranium in rocks. You will understand better how old this is when you realize that the earliest records we have of human history go back only about 5,000 years.

How Big Is the Earth's Surface? If you were to walk eight city blocks north, eight blocks east, eight blocks south, and eight blocks west, the square path you would take would make a line around about one square mile. On earth, there are about 196,940,000 square miles. This number of square miles makes up *the earth's area.*

How Much of the Earth's Surface Is Land? About 54,225,000 square miles, or three tenths of the earth's surface. About 5,100,000 square miles of this land is in Antarctica, which is too cold to be settled.

How Much of the Earth's Surface Is Water? About 142,715,000 square miles, or seven tenths of the earth's surface.

How Far Is It Around the Earth? The earth is fatter around its "waist," called the *equator*, than it is around the North and South Poles. A measuring tape around the equator would measure 24,902 miles. This is the *equatorial circumference* of the earth. Placed around the poles, the tape would measure 24,860 miles. This is the *polar circumference.*

How Far Is It Through the Earth? A "yardstick" driven into the earth would have to be about 7,927 miles long to measure the distance through the earth at the equator, or the *equatorial diameter*. Through the poles, the distance is about 7,900 miles. This is the *polar diameter*. The *average diameter* is 7,918 miles.

How Much Does the Earth Weigh? Scientists speak of the *mass* of the earth rather than the weight, because weight is the result of the gravitational pull of the earth. But if we could put the earth on a scale, we would find its weight to be about 6,600,000,000,000,000,000,000 (6.6 sextillion) tons. Just to give an idea how big this figure is, a sextillion is a thousand times a million times a million times a million. Scientists say that a constant shower of cosmic dust adds about 2,000,000 tons a year to the earth's weight.

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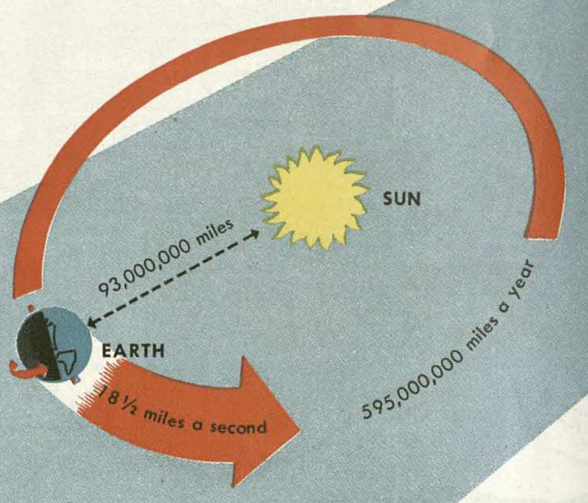
rise in the east, move across the sky, and then disappear behind the earth in the west.

The Earth Revolves Around the Sun, Making Years. The earth also travels, or revolves, around the sun. It takes the earth just 365 days, 6 hours, 9 minutes, and 9.54 seconds to make this trip. We call this period of time a *year*. To complete its path around the sun in this time, the earth has to travel an average of 66,600 miles per hour, or about 1,600,000 miles a day. The earth stays about 93,000,000 miles away from the sun. This seems like a great distance, but the earth goes this far in about 60 days in its 595,000,000-mile path, or *orbit*, around the sun. See ORBIT.

The Earth Tilts on Its Axis, Making Seasons. The earth tilts to one side as it goes around the sun. This tilt makes the sunlight strike the earth differently at different times of the year. This is the reason why summers are warmer than winters. The earth tilts 23½ degrees with respect to the path it follows around the sun. See SEASON.

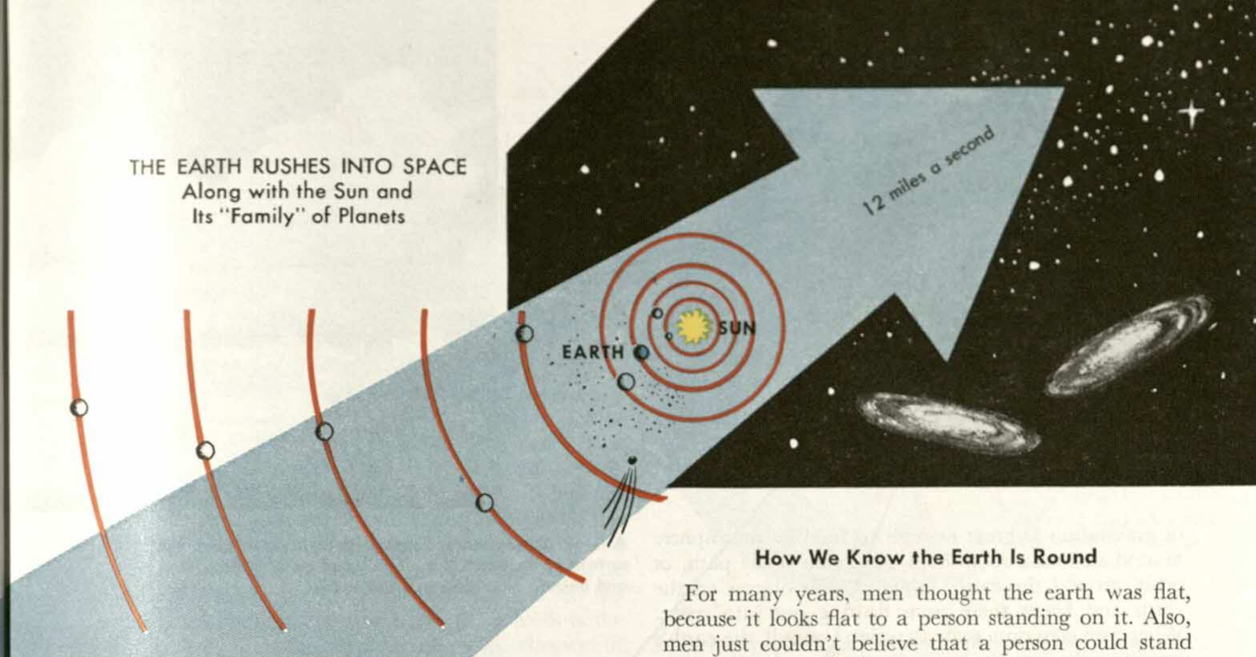
The Earth and Its "Family" Travel Through Space. The earth also dashes through space at a speed of about 43,000 miles per hour, along with its sister planets, the sun, and the other, smaller bodies (called *asteroids*) in the solar system. As the earth revolves about the sun, and follows it off into space, its path is a gigantic *helix*, or screwlike curve, resembling a winding staircase. As you read this page, the earth has gone about a million

THREE MOTIONS OF THE EARTH



THE EARTH REVOLVES AROUND THE SUN,
Making Years

THE EARTH SPINS, OR ROTATES,
Making Day and Night



THE EARTH RUSHES INTO SPACE
Along with the Sun and
Its "Family" of Planets

miles farther on its path through space than it had at the same hour yesterday.

The Shape and Size of the Earth

The earth is almost completely round. But the force of the spinning, or *rotation*, of the earth pulls the equator out a little, making the earth fatter around the middle. The distance through the earth from the North Pole to the South Pole is about 7,900 miles. The distance through the earth at the equator is about 7,927 miles.

Information gathered by scientists during the International Geophysical Year indicated that the earth may be somewhat pear-shaped.

The earth is the fifth largest planet. Mercury, the smallest planet, is only about 3,100 miles in diameter. The giant Jupiter is about 86,000 miles in diameter.

It is estimated that the earth weighs about 6,600 million million million tons. Its weight, or mass, is compared with an equal amount of water to find its *density*, which is 5.52. This means that if some imaginary giant carried the earth in one hand and a bag of water of the same size in the other, the earth would weigh about five and a half times as much as the water. Astronomers say that the sun has a density of 1.41; Jupiter, 1.33; and Saturn, 0.73. Saturn has a diameter of 70,000 miles, but it is so light that it could float on water.

It is hard to believe that the earth is as smooth as it is. If the earth were reduced to the size of a 12-inch school globe it would be smoother than any such globe you have ever seen. Tiny scratches in the varnish on a school globe would then be deeper than the Grand Canyon or the deepest valleys on the real earth. Tiny bumps and specks of varnish on the school globe would be higher than the highest mountains. If you were to dip the school globe into a bucket of water and then lift it out, the water that would cling to it would be about as deep as the oceans would be if the earth were the same size as the globe.

How We Know the Earth Is Round

For many years, men thought the earth was flat, because it looks flat to a person standing on it. Also, men just couldn't believe that a person could stand on the "underside" of a round earth without falling off. Some persons thought that the earth was like a saucer, and that if you came to the edge you would fall off.

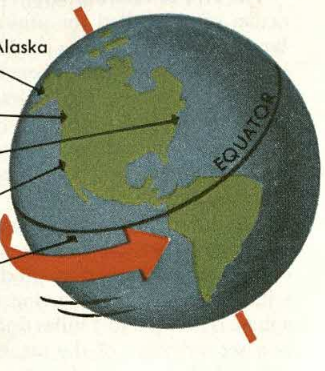
Today we know the earth is round. Here are some of the ways to prove this. When you see a ship sail into the distance, it gradually "sinks" below the horizon. In an airplane, you can fly entirely around the world and come back to the place you started. High-flying rockets have taken photographs that show the rounded curve of the earth's surface. And when the earth comes between the sun and the moon, you can see the rounded shadow of the earth on the moon. This shadow is called a *lunar eclipse*. See ECLIPSE.

The Earth's Two Great Forces

The Earth's Force of Gravitation. An object falls to the ground because the earth pulls objects toward it. We call this pulling force *gravitation*. The earth's force

SPEED OF THE EARTH

The North Pole and South Pole move slowly—they just turn around once every 24 hours. But a point on the equator has to go almost 25,000 miles a day — over 1,000 miles per hour—to keep up with the poles. Points between the equator and poles move at different speeds, depending on their distance from the equator.



6 miles a minute at Nome, Alaska

11½ miles a minute at Vancouver

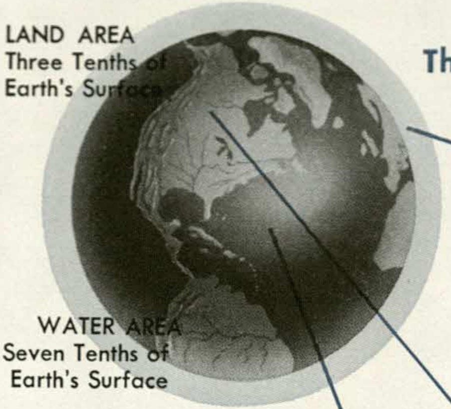
12¾ miles a minute at New York City

13½ miles a minute at San Francisco

17½ miles a minute at the equator

TRY IT ON A GLOBE
You can demonstrate these differences in rotation speeds by putting thumbtacks in a globe, then spinning it.

The Three Parts of the Earth


LAND AREA
Three Tenths of Earth's Surface
WATER AREA
Seven Tenths of Earth's Surface
AIR
LAND
WATER

of gravitation is great enough to hold its atmosphere around it, and also to hold the moon in its path, or orbit, around the earth. Gravity holds objects on the earth and keeps them from floating out into space. When you step on a scale to weigh yourself, the earth's gravity pulls you down on the scale and shows your weight. Without this force of gravity, you would not weigh anything. Gravitation on the earth's surface is greater at the poles than at the equator. A boy who weighs 100 pounds at the equator would weigh about a half pound more at the North or South Pole, because of this difference in gravitation. See GRAVITATION.

The Earth as a Magnet. The earth is a magnet. One magnetic pole is near the earth's North Pole, the other near the earth's South Pole. For this reason, a compass needle points north and south. Magnetic storms take place in the air which surrounds the earth. These storms interfere with short-wave radio reception. Besides the magnetic poles, there is also a magnetic equator. See MAGNET AND MAGNETISM.

The Three Parts of the Earth

We usually think of the earth as a solid object. We say that an airplane comes down to earth from the sky, or that it is good to feel solid earth under our feet after a boat trip over the water. But, actually, the sky and the water are as much a part of the earth as the solid ground is. The earth is made up of three things: air, land, and water. Land is a solid, water is a liquid, and air is a gas.

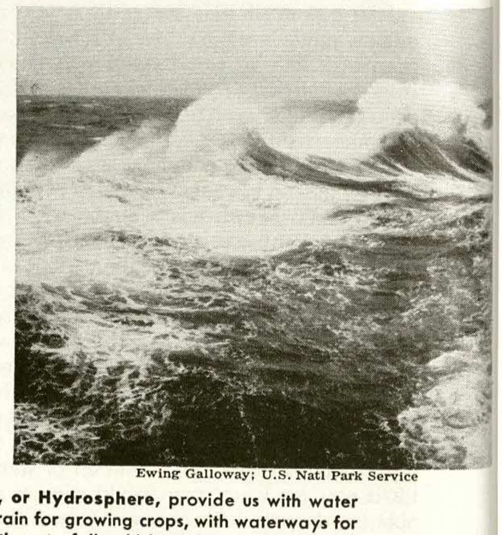
The Air, or Atmosphere. We live at the bottom of an ocean of air, called the atmosphere, which covers the lands and waters of the earth. No one knows just how high the air goes. But it becomes thin and spacelike at a height of only 120 miles. The colorful northern lights, or *aurora borealis*, are in the atmosphere probably about 400 miles above the earth. Meteorites become fiery hot when they pass through the air at about 100 miles above the surface.

The lower atmosphere, sometimes called the *troposphere*, is where our weather is made. This is the part of the atmosphere that produces clouds, rain, snow, winds, storms, and changing temperatures. The troposphere is about 6 to 7 miles thick. Above the troposphere is a second zone of the atmosphere, called the *stratosphere*. It has no clouds and is very cold.

The atmosphere has weight. A column of air one

Air, or Atmosphere, forms a thick layer around the surface of the earth. It is made up of gases which plants and animals must have in order to live.

Land Areas, or Lithosphere, make up the continents and islands, as well as the bottoms of oceans. Only on the lithosphere have men made permanent homes.



Ewing Galloway; U.S. Natl Park Service

Water Areas, or Hydrosphere, provide us with water to drink, with rain for growing crops, with waterways for trade, and with waterfalls which we harness for power.

inch square, reaching to its uppermost limits, weighs 14.7 pounds at sea level. We do not feel the weight of the atmosphere at ordinary elevations, because our bodies are adjusted to it. The atmosphere is heaviest near the earth. The air extending $3\frac{1}{2}$ miles up from sea level weighs as much as the air for about 500 miles above it. As a person goes into the upper atmosphere, the air pressure becomes less, and he may suffer from lack of oxygen in the air. High-flying airplanes pump air into their sealed cabins, or *pressurize* them, so the passengers can breathe as easily as they could at sea level. See AIR; STRATOSPHERE; WEATHER.

The Land Areas, or the Lithosphere. If you dig a hole through the earth, you would find several different kinds of material. The lithosphere is divided into various zones, from its surface to the center of the earth. It is essentially a solid body as rigid as steel. First comes the *outer shell*. This is sometimes cracked by forces inside the earth which cause earthquakes. The *mantle* is the next lower, or inner, zone. It responds to the earth's forces by flowing like hot fudge under pressure. The *outer core* lies beneath the mantle. At the center of the earth is the *inner core*. This inner core is also called the *centrosphere* or *barysphere*. These four zones were determined by the study of earthquake waves.

The outer shell consists of two thin portions. These are the outer, or *continental*, layer and the inner, or *subcontinental*, layer. The continental layer is mostly granite. It is the foundation of all continents and has a density of about 2.75. The subcontinental layer is mostly basalt, and has a density of about 3.3. It lies beneath the continents and makes up the ocean bottoms. The total average thickness of these two layers of the outer shell is about 20 miles. The thicknesses of these layers and of all other zones of earth are different at different places on the earth.

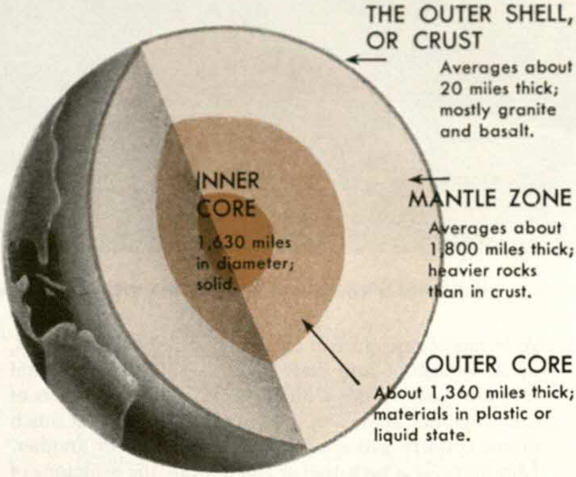
The surface of the outer shell is very irregular. The highest point is Mount Everest (29,028 feet above sea level), and the lowest point is off Guam in the Mariana Trench of the Pacific Ocean (35,800 feet below the ocean surface). The top of Mount Everest rises more than 12 miles above this low point.

The layers of the lithosphere are not separate like the layers of an onion. Each layer blends into the next. The rocks get hotter, the deeper they are. At 250 miles down, a person would bake like a potato in seconds.

Beneath the outer shell, each zone increases in density toward the center of the earth. The mantle zone is about 1,800 miles thick. It has heavier rocks than those in the crust. The outer core is approximately 1,360 miles thick. The materials in this layer are believed to be hot and flowing, or *plastic*, because of the tremendous pressure upon them. Some kinds of earthquake waves are reflected at the base of this layer. The inner core is about 1,630 miles in diameter. It is thought to be solid and composed of iron and nickel.

The Water Areas, or Hydrosphere. If all the deep places of the oceans were filled in, and all the high places on land were leveled, the earth would be a smooth ball. But people would have a hard time living on it, because water would cover this smooth ball to a depth of 8,000 feet.

Water in oceans, seas, lakes, and rivers makes up the third of the three parts of the earth, called the *hydrosphere*. Oceans cover about seven tenths of the earth's surface. The average depth of all the oceans is about $2\frac{1}{2}$ miles.


WHAT'S INSIDE THE EARTH
THE OUTER SHELL, OR CRUST
Averages about 20 miles thick; mostly granite and basalt.
MANTLE ZONE
Averages about 1,800 miles thick; heavier rocks than in crust.
OUTER CORE
About 1,360 miles thick; materials in plastic or liquid state.
INNER CORE
1,630 miles in diameter; solid.

The hydrosphere, like the atmosphere, has weight A column of sea water one inch square and a thousand feet high would weigh about 437 pounds.

In addition to the oceans, seas, lakes, and rivers, there is water almost everywhere, just beneath the surface of the land. This is the water that soaks into the ground from rain and snow. See GROUND WATER.

How the Earth Changes

The earth is constantly changing. Mountains are being worn away and flat lands are being lifted to form new mountains. We need not look back to ancient times to discover how the various features of the earth came to be, for some of the same changes are taking place today that occurred millions of years ago.

How the Land Is Being Worn Away. Slowly, but surely and steadily, the great mountains and highlands of the earth are being eaten away. For the forces of *erosion* (which means *wearing away*) are at work. Water is the mightiest of these forces. Rivers wear away rock and soil, and drop millions of tons of mud and sand into the oceans every day. So the ocean bottoms are slowly built up as the mountains and highlands are ground down.

Ice is another force of erosion. When water freezes, it pushes out, or expands, with a tremendous force. A little water in a tiny crack of a rock will freeze and force the crack bigger. Rivers of ice, called *glaciers*, carry boulders and rocks which wear away the earth's surface. Where the glaciers stop flowing, they leave large piles of these boulders and rocks.

Even the wind plays its part in tearing down the land. Strong winds pick up tiny grains of sand and blast these against cliffs and rocks. See EROSION.

How Mountains Are Made. While the forces of erosion are tearing at the earth's surface and wearing away the mountains and highlands, other forces are at work building new ones. There are several ways in which mountains and highlands are made.

Large parts of the United States were once sea bottoms. You can find fossil sea shells, and even the fossil

The World Is Round—As You Can See from This Amazing Rocket's-Eye View of the Earth's Curvature. Mexico

skeletons of ancient fish and other strange sea animals, in the limestone and shale rocks that lie under the soil in many parts of the United States. The deep layers of limestone and shale are, in themselves, proof that much of our country was sea bottom at one time or another. Limestone is a rock that is made from the skeletons of tiny sea animals. Shale is a rock that is made from mud.

What caused the sea bottoms to rise and make dry lands? When running water has dumped enough mud and sand into the ocean, the ocean bottom becomes extremely heavy. Sometimes the mud and sand pile up several miles thick, and this heavy mass settles deeper and deeper into the rocks beneath. Finally, the weight of these *sediments* becomes so great that the rocky crust around them breaks and folds. The sediments are then slowly pushed up by the great pressures that are created under them. Over millions of years, the sea bottom slowly rises and becomes highlands. Then erosion tears the highlands down again and carries the sediments into new seas. After hundreds of millions of years, enough sediment settles in these new seas for them, in turn, to create tremendous pressures in the earth's crust. These sediments then begin to rise and parts of the surrounding land sink slowly down to become ocean bottoms again.

In many parts of the earth today, you can see high mountains which are made of sedimentary rock that has been lifted, folded, and changed by pressure. They are so folded and warped that the different-colored layers of former sediments are twisted and folded up and down like a rocky sculpturing of ocean waves. See ROCK.

Sometimes the pressure on the rocks is so great that they snap apart. One section moves sideways, or up, and the other section moves the other way, or down. This snapping and moving of the earth's outer crust is an *earthquake*. See EARTHQUAKE.

Another kind of mountain is built by melted rock that volcanoes pour out on the earth's surface.

Many of the mountains in the western United States are ancient volcanoes. Mount Rainier, Mount Shasta, and Lassen Peak are among the best known and the most perfectly shaped volcanic cones in the United States. But, in addition to these volcanic cones, great areas of Washington and other western states are covered with lava which poured out of the earth and flowed over it long, long ago. See VOLCANO.

The Earth as Man's Storehouse

The earth is good to man. It is a great storehouse of materials he uses for his many purposes. It produces the food he eats, and gives him the materials for his clothing and his shelter. The earth's crust gives man the minerals from which he makes thousands of things, from medicines to steel.

The oceans provide us with food, and with such minerals as salt and iodine. The light metal called *magnesium*, which is used in airplanes, is mined from the ocean.

Even the atmosphere is a storehouse. The atmosphere protects us from the fierce bombardment of cosmic rays and ultraviolet light and gives us and all other living things the oxygen needed for life. But, in addition, man has learned to separate the gases of the atmosphere and to use them for many purposes. Nitrogen from the air is used to make fertilizers for growing plants. Oxygen from the air is used to produce a fierce, hot flame that will cut through steel.

How the Earth Began

Many scientists believe that the earth was born when another star crashed into the sun, or passed very near it. There have been several variations of this theory. The astronomer Forest R. Moulton and the geologist T. C. Chamberlin, both of the United States, proposed about 1900 the theory that the passing star raised giant tides on the sun. Matter was torn loose from the sun and sent spiraling around it. Most of this matter fell back into the sun or was lost in space. But some of it clustered around small fragments called *planetesimals*, and after about twenty million years formed the planets. This explanation of the formation of planets is called the *planetesimal hypothesis*.

Two noted English scientists, Sir James Jeans and Harold Jeffreys, presented in 1929 their *gaseous element* theory. According to this theory, the passing star pulled out of the sun a long streamer, or *filament*, of hot gases which formed beadlike lumps that became the planets. See GEOLOGY (How the Earth Began).

The Age of the Earth

Scientists differ in their conclusions about the age of the earth. For example, Lord Kelvin of Great Britain made estimates which ranged from 20,000,000 to 400,000,000 years. Several methods have been used for determining the age of the earth. One of these is the uranium-lead method. Uranium is a radioactive element which breaks up, or *disintegrates*, at a constant rate that can be measured. It gives off helium atoms and leaves lead behind. By measuring the amount of uranium and lead in uranium-bearing rock, scientists

United Press Int.

and the Gulf of California Are Shown at the Left of the Picture, and Northern New Mexico Is at the Right

can find the number of years ago that the uranium was formed, assuming it started as pure uranium. In 1957, a group of American scientists found evidence that fixes the age of the earth at about 4,500,000,000 years.

The Earth as a History Book

The entire earth has written its history for us to read. That history is in the rocks. For example, the rocks show us that great glaciers moved down several times over the North American continent and Europe, completely covering large parts of each. Great boulders and glacier-scratched rocks show where these glaciers went and which way they moved. Fossils of all sorts, from tiny plants to giant dinosaurs, give us a record of the life that lived on our earth before the time of man. Ripple marks in solid rock show us where ancient seas once lapped gently on sandy shores. And bent, baked, twisted rocks of all sorts tell us a great deal about how the thin outer crust of mother earth has changed, and changed again, since the earth began.

Chemical Composition of the Earth

The earth contains all the known chemical elements, in various proportions and combinations. The earth's crust is mostly granite. It has this average composition, based on an analysis of Finnish granite:

Silicon dioxide, SiO_2	—	67.0 %
Aluminum oxide, Al_2O_3	—	15.0 %
Iron oxide, $FeO+Fe_2O_3$	—	4.41%
Calcium oxide, CaO	—	3.4 %
Sodium oxide, Na_2O	—	3.07%
Potassium oxide, K_2O	—	3.5 %
All others	—	3.62%

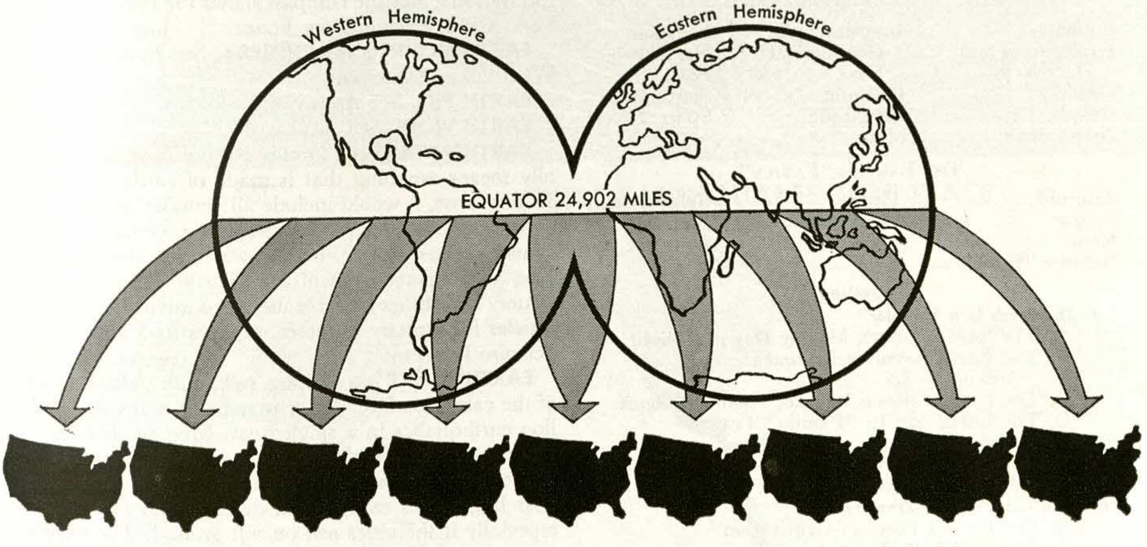
Superstitions and Theories About the Earth

Man through all the ages has had ideas about the earth. Some were superstitions and myths (see MYTH [Myths Concerning the Creation of the World]). Others were based on facts. The Egyptian-Greek astronomer, Ptolemy (about A.D. 150), taught that the earth was round, but that it was the center of the solar system. About thirteen hundred years later, the Polish astronomer, Copernicus (1473-1543), arrived at the idea of a solar system almost as we know it today, with the planets revolving around the sun. Galileo (1564-1642), the Italian astronomer, confirmed the Copernican theory by astronomical observations (see GALILEO).

During the Middle Ages in Europe, many people believed the earth was flat, but some maintained that it was round.

SIDNEY E. EKBLAW and R. WILL BURNETT

HOW FAR IS IT AROUND THE EARTH?



The Distance Around the Equator Is ABOUT NINE Times the Distance Across the United States.

EARTH

Related Articles. See the Earth and Its Resources section in the Reading and Study Guide. See also the following articles:

Motions and Forces of the Earth

Climate
Equinox
Gravitation
Magnet and Magnetism
Season
Zone

The Atmosphere (Air)

Air
Atmosphere
Aurora Borealis
Cloud
Frost
Ionosphere
Meteor
Rain
Sky
Snow
Stratosphere
Tropopause
Troposphere
Weather
Wind

The Lithosphere (Rocks)

Continent
Island
Rock
Soil

The Hydrosphere (Water)

Deep
Geyser
Ground Water
Hydrosphere
Lake
Ocean
River
Water
Waterfall

The Changing Earth

Coral
Delta
Desert
Earthquake
Erosion
Floods and Flood Control
Glacier
Lava
Mountain
Valley
Volcano
Wind

The Earth as the Home of Living Things

Acclimatization
Adaptation
Animal
Biosphere
Ecology
Environment
Geography
Man
Nature Study
Plant
Population
World

The Earth as Man's Storehouse

Atomic Energy
Clothing
Coal
Conservation
Element, Chemical
Food
Iron and Steel
Mineral
Natural Resources
Petroleum
Radiation
Shelter
Water Power

The Earth as a History Book

Dinosaur
Fossil
Geology
Ice Age
Paleontology
Petrified Forest
Prehistoric Animal
Prehistoric Man

Exploring and Mapping the Earth

Equator
Exploration and Discovery
Geodesy
Geophysics
Hemisphere
International Geophysical Year
Latitude
Longitude
Map
Meridian
North Pole
Pole
South Pole
Space Travel

The Earth's "Family"

Asteroid
Eclipse
Moon
Nebular Hypothesis
Planet
Planetesimal Hypothesis
Solar System
Sun
Universe

Outline

I. The Earth Is a Traveler
  A. The Earth Rotates, Making Day and Night
  B. The Earth Revolves Around the Sun, Making Years
  C. The Earth Tilts on Its Axis, Making Seasons
  D. The Earth and Its "Family" Travel Through Space
II. The Shape and Size of the Earth
III. How We Know the Earth Is Round
IV. The Earth's Two Great Forces
  A. The Earth's Force of Gravitation
  B. The Earth as a Magnet
V. The Three Parts of the Earth
  A. The Air, or Atmosphere
  B. The Land Areas, or the Lithosphere
  C. The Water Areas, or Hydrosphere
VI. How the Earth Changes
  A. How the Land Is Being Worn Away
  B. How Mountains Are Made
VII. The Earth as Man's Storehouse
VIII. How the Earth Began
IX. The Age of the Earth
X. The Earth as a History Book
XI. Chemical Composition of the Earth
XII. Superstitions and Theories About the Earth

Questions

How large is our earth compared with the sun?

What are the three different motions of the earth?

Why don't we fly off the earth into space?

If the earth were reduced to the size of a twelve-inch globe, how high would the mountains be?

How deep are the deepest ocean depths?

What are the three main parts of our planet, the earth? In which of these parts would you swim?

If you weighed fifty pounds at the equator, how much more would you weigh at the poles?

If you could dig a hole through the earth, what different kinds of materials would you find?

Is the surface of the earth changing today?

How thick is the earth's atmosphere? How can pilots fly where there is little oxygen in the air?

EARTH CURRENT is an electrical current that passes through the earth. Natural forces produce some currents, while others are man-made.

EARTH INDUCTOR COMPASS is a compass that measures the electromotive force caused by the earth's magnetic field. It is used principally by airplane pilots. A coil in the compass rotates around a vertical axis. The pilot sets his course so that the needle points to zero. If he flies off course to the right, the needle moves to the right of zero. Then the pilot turns his plane to the left so that the needle moves the same distance to the left of zero. After he has flown as long in the second direction as he did in the first, he brings his ship back on course by turning right again until the needle reaches zero. This compass is extremely accurate. The slightest turn away from the magnetic field reduces the electromotive force and the compass shows the error. See also Compass; Electromotive Force. John J. Floherty

EARTH-MOVING MACHINERY. See Building and Wrecking Machines.

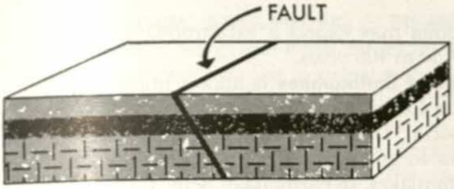
EARTH PIG. See Aardvark.

EARTH WOLF. See Aardwolf.

EARTHENWARE is a form of pottery. The word literally means anything that is made of earth materials. In this sense, it would include all ceramic articles. But earthenware has come to mean only a certain type of coarse, porous pottery. Earthenware will absorb moisture, while porcelain will not. Earthenware includes pottery and dishes for table use, decorative objects, and articles for sanitary purposes, such as food containers. See also Pottery. Charles M. Harder

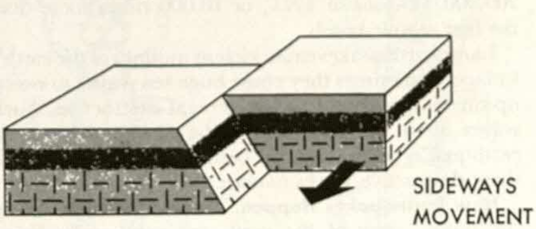
EARTHQUAKE is a shaking, rolling, or sudden shock of the earth's surface. There may be as many as a million earthquakes in a single year. Most of them take place beneath the surface of the sea. Comparatively few of these cause any damage. But earthquakes that occur near large cities cause much damage and loss of life, especially if the cities rest on soft ground. The energy released by a large earthquake may be equal to about

EARTHQUAKE

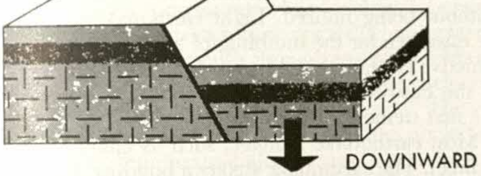


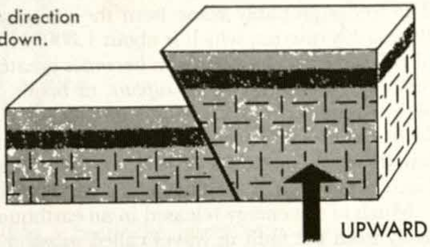
WHAT CAUSES AN EARTHQUAKE

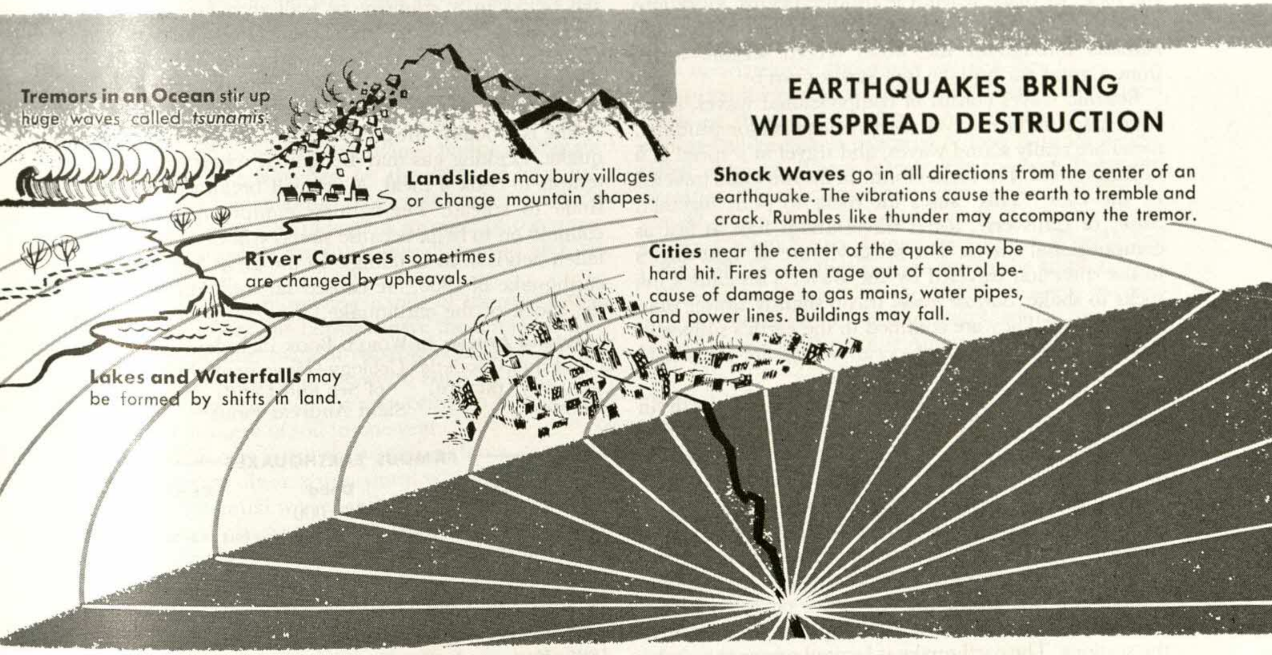
Sudden Movements of Rock beneath the earth are the main cause of earthquakes. Stresses in the earth cause blocks of rock to break, then move along a *fault*, or crack.



Rocks and Earth may slip in any direction along a fault—sideways or up and down.







EARTHQUAKES BRING WIDESPREAD DESTRUCTION

Shock Waves go in all directions from the center of an earthquake. The vibrations cause the earth to tremble and crack. Rumbles like thunder may accompany the tremor.

Cities near the center of the quake may be hard hit. Fires often rage out of control because of damage to gas mains, water pipes, and power lines. Buildings may fall.

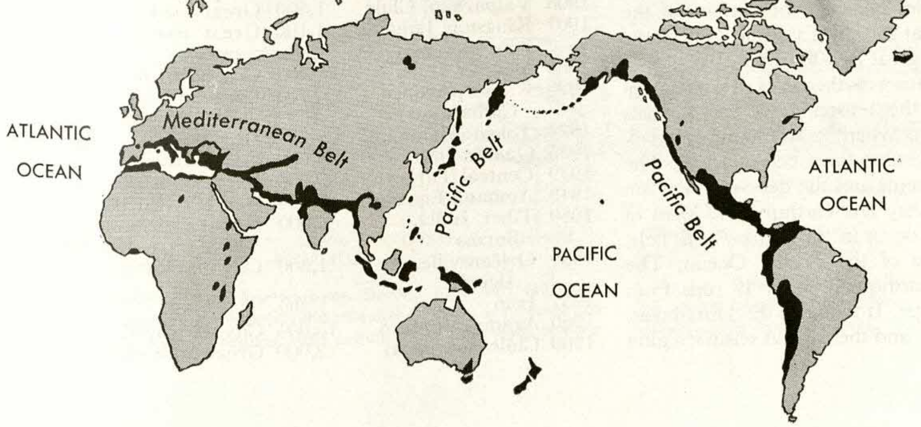
Tremors in an Ocean stir up huge waves called *tsunamis*.

Landslides may bury villages or change mountain shapes.

River Courses sometimes are changed by upheavals.

Lakes and Waterfalls may be formed by shifts in land.

WHERE EARTHQUAKES TAKE PLACE



Almost 95 out of 100 earthquakes occur in two great belts—the Pacific Belt and the Mediterranean Belt. Most of the world's active volcanoes and young mountain ranges are in these areas. An erupting volcano sometimes may cause an earthquake.

200,000,000 tons of TNT, or 10,000 times more than the first atomic bomb.

Large earthquakes cause violent motions of the earth's surface. Sometimes they cause huge sea waves to sweep up on land and add to the general destruction. Such waves often occur in the Pacific Ocean, because of earthquakes within ocean basins. The Japanese call these destructive waves *tsunami*.

How Earthquakes Happen. The rocks that make up the outer layers of the earth are continually being squeezed and stretched by forces from within the earth. The forces probably come from the enormous heat of the earth's interior, which is about 1,800° F. at a depth of 100 miles. When the strain becomes greater than the rocks can stand, the rocks *rupture*, or break, and cause an earthquake. These ruptures in the rock are called *faults*. Most earthquake faults lie beneath the surface, but some are visible on the surface. The Saint Andreas Fault, which can be seen in California, is 600 miles long.

Much of the energy released in an earthquake travels away from the fault in waves called *seismic waves*. Near the *focus*, or place where the rupture begins, vibrations of the seismic waves can be destructive. Seismograph stations throughout the world record seismic waves from a great earthquake (see SEISMOLOGY).

Seismic waves consist of compressional waves, shear waves, and surface waves. *Compressional*, or longitudinal, *waves* are really sound waves, and travel at a speed of 5 miles a second. The rocks vibrate in the direction traveled by the wave. This causes the rocks to push together. *Shear*, or transverse, *waves* travel about half as fast as compressional waves. The rocks vibrate at right angles to the direction traveled by the wave. This causes the rocks to shake. *Surface waves* travel slightly slower than shear waves. They are confined to the earth's surface in much the same way that ocean waves are limited to the surface of the sea.

Seismic waves pass directly through the earth in about 21 minutes. By measuring their speed, scientists can obtain some idea of the kinds of rocks that are found below the surface of the earth. They can also determine the amount of pressure at great depths.

Location of Earthquakes. Seismologists locate earthquakes by studying the time intervals at which the different seismic waves reach a number of seismographic stations (see SEISMOGRAPH). They draw circles on a map to show the distance of the earthquake from each of the stations. The earthquake is located where the circles intersect one another. The focus of most earthquakes occurs less than 25 miles beneath the surface of the earth. A few take place at the earth's surface, and some may occur at depths as great as 400 miles.

The same force that causes earthquakes caused mountains to be made. For this reason, large earthquakes usually occur along belts where new mountains, volcanoes, and deep-sea trenches have been formed. The older, flat parts of continents and the deep-sea floor are stable areas that have very few earthquakes. Most of the world's earthquakes occur in the *circum-Pacific* belt, which follows the edges of the Pacific Ocean. The *Alpide belt* is another earthquake belt. It runs from Burma to southern Europe. It includes the Himalayas, the Caucasus Mountains, and the Alps. A seismic region like California may expect a catastrophic earthquake once every 50 to 100 years.

Prediction of Earthquakes is almost impossible. But scientists do know the regions where earthquakes are likely to occur. They may use the history of previous earthquakes to guess how often a certain region may expect earthquakes. In earthquake belts, the earth continually undergoes adjustments. Scientists know that these adjustments will continue, and that certain regions will occasionally have earthquakes of some kind. In such regions, engineers have developed houses and other structures that can withstand the most severe earthquake tremors. Many cities require buildings to conform to certain safety regulations. The use of reinforced concrete has helped avoid earthquake damage.

Damage by Earthquakes. Most earthquakes pass without being noticed. Light earthquakes may easily be mistaken for the rumbling of a truck. But large, destructive earthquakes do occur from time to time. Most of the destruction takes place about 10 seconds after the first tremor of the earthquake is felt.

Most earthquake damage, such as falling rubble, is indirect. The earthquake shakes a building, and loosens the bricks in a chimney or wall that falls and hurts someone. Most of the damage occurs outside, rather than inside, a building. Earthquakes may also damage water pipes so that the water gushes out. They often knock down electric lines and break gas mains.

Fire is probably the greatest single danger in an earthquake. Leaking gas may be ignited when someone attempts to cook a meal. A fire will break out and continue to spread. Fire-fighting equipment cannot be counted on to help, because streets will be stacked with fallen debris from buildings. In the great San Francisco earthquake of 1906, fire caused far more damage than the shock of the earthquake.

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Related Articles in WORLD BOOK include:

Coast and Geodetic Survey (picture)
Disaster
Geology (Movement of Sea and Land)
Saint Andreas Fault
Seismograph
Seismology

FAMOUS EARTHQUAKES

Year	Location	Dead	Remarks
1556	China	830,000	
1755	Lisbon, Portugal	10,000	Great sea wave
1783	Calabria, Italy; Sicily	60,000	
1822	Aleppo, Syria	22,000	Destroyed city
1886	Charleston, S.C.	41	Most of city destroyed
1897	India (Assam)	Unknown	Felt 900 miles away
1905	Kangra, India	20,000	
1906	San Francisco	452	Swept by fire
1906	Valparaiso, Chile	1,500	Great loss by fire
1907	Kingston, Jamaica	1,100	Great loss by wave and fire
1908	Messina, Italy	76,483	City partly destroyed
1920	Kansu province, China	200,000	Large area affected
1923	Tokyo; Yokohama	99,331	Huge property loss
1935	Quetta, India	56,000	City destroyed
1939	Central Turkey	50,000	Large area affected
1949	Ambato, Ecuador	6,000	Most of city destroyed
1950	Tibet, India, Burma	5,000	Mount Everest said to have risen 198 feet
1954	Orléansville, Algeria	1,600	City destroyed
1957	Iran	1,392	
1960	Agadir, Morocco	15,000	City destroyed
1960	Chile (southern)	2,000	Great tidal waves

EARTHWORM, ANGLEWORM, or **FISHWORM,** is a worm found in warm and moist places throughout the earth. The earthworm has a long slender body that is covered with a slimy fluid. It is called *angleworm* and *fishworm* because it is a popular bait used by fishermen. Its body is divided into segments, or rings, and is red-brown in color. It ranges in length from one twenty-fifth of an inch to several feet. The earthworm has no eyes. On each segment, however, there is a pair of spots sensitive to light.

How It Moves. The earthworm is provided with four double rows of bristles, two rows underneath and one row on each side of the body. It helps to pull itself along by contracting two kinds of muscles. One kind lies along the length of the body and the other circles the body. As it moves, it forms a round burrow. It is said to make slight clicking sounds while forming its burrow.

The earthworm eats its way through the harder layers of soil which it cannot push through easily. It feeds on decaying vegetable matter, and at night busily searches for fragments of leaves to drag into its burrow. The soil and waste pass out of the digestive canal and are left on the ground in little heaps called *castings*.

The earthworm normally lives in the warm, dark ground. It becomes very weak when it is in strong daylight and cold air. It can usually be seen lying on the ground and on walks after a rainstorm. Scientists believe that it comes to the surface to get air because the soaking rain water drives out the air in the small openings of the soil. The weak or dying condition of many such earthworms is caused by the effect of light and cold on their tender skins. The earthworm reproduces by means of eggs laid in a hard capsule, or container. If some earthworms are cut in two, the head end can grow a new tail.

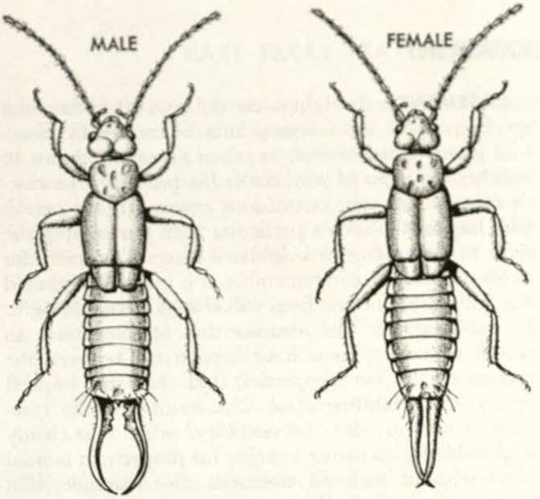
Its Value. The burrowing habits of the earthworm make it valuable. The burrows leave the soil laced with tiny air holes, and make it capable of holding air and moisture. The castings of the worm build up topsoil and make it fertile. Earthworms may bring 10 tons of castings to top an acre of soil in one year.

The earthworm is not the young, or larva, of moths, or other insects. It is a true worm which belongs to a group of segmented worms called *annelids*.

Scientific Classification. The common earthworm belongs to the family *Lumbricidae*. It is genus *Lumbricus*, species *terrestris*.

J. A. McLEOD

See also ANIMAL (color picture, Leading Groups in the Animal Kingdom); WORM (picture).



Male and Female Earwigs. The pincers at the end of the abdomen are strong and movable. So far no one has been able to determine how the insect uses them.

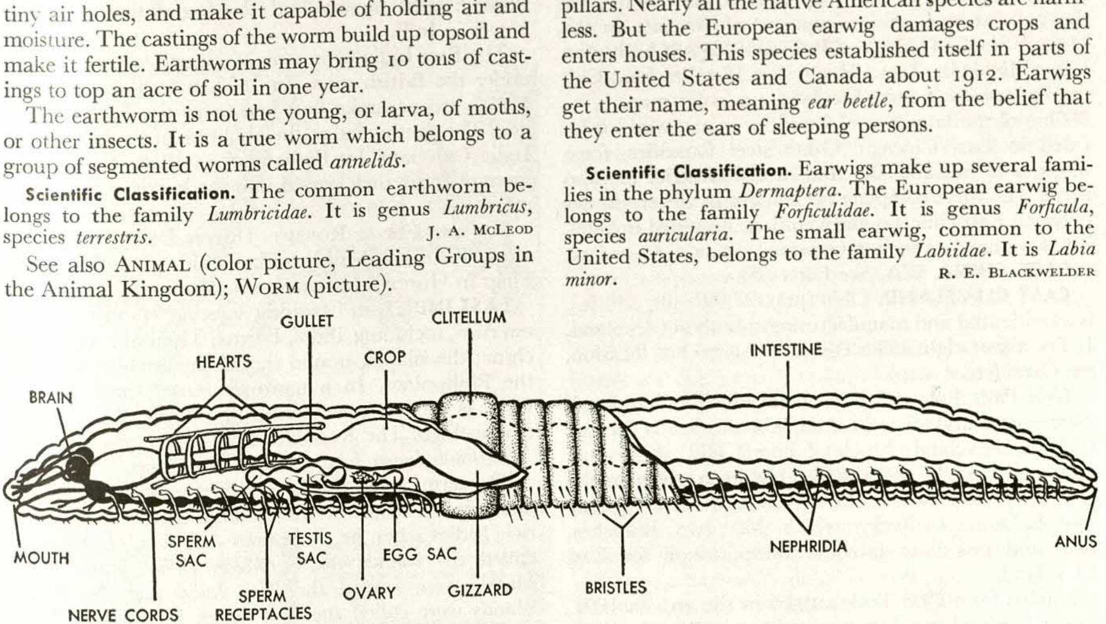
EARWIG is a beetlelike insect with a large pair of pincers at the rear of its body. Earwigs may be found under stones, in decayed bark of trees, and in moist places. They come out and are most active at night. Most earwigs grow about half an inch long.

Earwigs have a hard, shiny outer case. Their upper wings are short and leathery, while the lower ones appear gauzelike. Their heads carry long delicate feelers, called *antennae*. These insects live in most European countries. There are about 20 species of earwigs in the United States. A small species lives in the northern and eastern United States. Larger ones live in Florida and California. Most other species live in the tropics.

Earwigs sometimes destroy fruit and flowers, but they also aid the farmer by eating thrips, snails, and caterpillars. Nearly all the native American species are harmless. But the European earwig damages crops and enters houses. This species established itself in parts of the United States and Canada about 1912. Earwigs get their name, meaning *ear beetle*, from the belief that they enter the ears of sleeping persons.

Scientific Classification. Earwigs make up several families in the phylum *Dermaptera*. The European earwig belongs to the family *Forficulidae*. It is genus *Forficula*, species *auricularia*. The small earwig, common to the United States, belongs to the family *Labiidae*. It is *Labia minor*.

R. E. BLACKWELDER



The Body of the Earthworm. Strange as it may seem, the earthworm has ten "hearts," or aortic arches. Every earthworm has two sets of sexual organs. Male organs include the testis and the sperm sac. Female organs include the ovary and the egg sac. The broad band of the clitellum is used for reproduction. The nephridia, like human kidneys, give off waste matter.

EASEMENT is the right to use the land of another for a special purpose. An easement may be created by an actual grant or agreement, as when an owner grants to another the right of way across his property. An easement may also arise out of long custom. If the person who happens to own a particular farm has enjoyed the right to walk across a neighbor's piece of property for as long as people can remember, it is taken for granted that any owner of that farm will always have that right. In this case, the law assumes that at some time an actual agreement must have been made between the owners of the two properties, and that this implied agreement is binding upon all later owners. An easement is said to arise "by necessity" when it is clearly impossible for an owner to enjoy his property in normal ways without such an easement. For example, if a farmer sells half his farm to another, and if the new owner's property is completely shut off from the highway on all sides, the law holds that "of necessity" the seller intended to grant an easement to the buyer over the seller's remaining land.

William Tucker Dean

EAST, THE. See Far East; Orient.

EAST BENGAL. See Bengal.

EAST BERLIN. See Berlin.

EAST CAROLINA COLLEGE is a state-supported coeducational school at Greenville, N.C. It offers liberal arts and teaching courses leading to B.A., B.S., M.A., and M.S. degrees. The college was founded in 1907. For enrollment, see Universities (table).

EAST CENTRAL STATE COLLEGE is a coeducational state-controlled school at Ada, Okla. Courses in liberal arts and education lead to A.B., B.S., and A.B., B.S., and M.S. in Ed. degrees. East Central was founded in 1909 by the state legislature. For enrollment, see Universities and Colleges (table).

EAST CHICAGO, Ind. (pop. 57,669; alt. 590 ft.), has the greatest steelmaking capacity of any city in the United States. It also has Indiana's biggest harbor on Lake Michigan. East Chicago lies 18 miles from Chicago's business center. See Indiana (color map).

One of the largest steel foundries in the world is located in East Chicago. Other steel foundries, forge shops, a chemical plant, and metal refineries are also there. The most complete oil refinery in the world lies between East Chicago and Whiting. Founded in 1889, it has a mayor-council government.

Paul E. Million, Jr.

EAST CHINA SEA. See China Sea.

EAST CLEVELAND, Ohio (pop. 37,991; alt. 578 ft.), is a residential and manufacturing suburb of Cleveland. It lies about eight miles east of the city. For location, see Ohio (color map).

Nela Park, home of the General Electric Company's engineering and experimental laboratories, is located in East Cleveland. Much of Forest Hill, the former estate of John D. Rockefeller, has been given to the city for public parks. The city has about 10 public schools, and a library which has two branches. Rail and bus lines provide transportation for East Cleveland.

Settlers from New York arrived in the area in 1801. East Cleveland was incorporated as a village in 1895, and as a city in 1911. It has a council-manager form of government.

James H. Rodabaugh

EAST GERMANY. See Germany.

EAST INDIA COMPANY was a name given to several companies formed for trade with India and Southeast Asia. They received monopoly trading privileges from their governments. Such companies were established in England, Holland, France, and other countries. In English-speaking countries, the name "East India Company" usually refers to the British East India Company, which had the longest life and greatest success of all these organizations. This company not only opened the vast realm of India to British trade, but also was important in making it part of the British Empire.

Queen Elizabeth I gave the British East India Company a charter in 1600. This charter gave sole trade rights in the Indian and Pacific oceans to the "Governor and Company of Merchants of London Trading to the East Indies." The charter was granted for 15 years, and could be renewed. Later, the government used its right to renew the charter to limit the company's power.

Other countries also chartered companies and gave them trade rights in the East Indies. The English company came into conflict with the forces of these other nations. The Dutch and English joined to force Portuguese ships out of Pacific and Indian waters. Then the Dutch succeeded in gaining control of the islands that later became the Dutch East Indies. The British company centered most of its efforts on the mainland of India. The original charter gave the company the right to buy land and rule it under the laws of England. The company soon began to set up factories, or trading posts, in India and to make treaties with native rulers. The French, however, also had ambitions in India, and they won a number of native rulers to their side. Open war broke out between the French and British in the middle 1700's. Each country had allies among the Indian provinces. In 1757 the forces of the British company, led by Sir Robert Clive, won a great victory at Plassey. This victory laid the foundation of British power in India.

The East India Company continued to govern India under the British ruler. In 1857, a terrible mutiny of Indian troops broke out, known as the Sepoy Rebellion. The mutiny led to the abolition of the British East India Company by Parliament in 1858. The government of India then passed into the hands of the British ruler.

J. Salwyn Schapiro

See also Clive, Robert; Dutch East India Company; Flag (Birth of the Flag; color picture, Famous Flags in History); Sepoy Rebellion.

EAST INDIES, in its widest sense, refers to southeastern Asia, including India, Burma, Thailand, and Indochina; the islands around the Malay Archipelago; and the Philippines. In a narrower sense, the term *East Indies* is used to mean only the islands of the Malay Archipelago. The Republic of Indonesia, formerly the *Netherlands Indies*, forms part of this group.

The terms *Indies* or *Ind* were first used in the 1400's. Columbus thought he was finding a short route to the rich Indies when he discovered America. He therefore called the islands the *Caribbean Indies*. Later, these islands were named the *West Indies* and the Pacific islands were called the *East Indies*, in order to distinguish the two groups.

Justus M. van der Kroef

See also Animal (color picture, India, South Asia, and East Indies); Southeast Asia.

EAST LIVERPOOL, Ohio (pop. 22,306; alt. 685 ft.), is called the *Pottery Center of America.* It lies on the Ohio River across from the Panhandle region of West Virginia (see OHIO [color map]). The city was founded in 1798, but its real growth began when James Bennett opened the first pottery there in 1840. The abundance of clays and natural gas in the region soon attracted a number of potters, especially from the Stafford district of England. Early potteries made Rockingham ware, yellowware, whiteware, and cream-colored ware. Today, East Liverpool has one large pottery. It manufactures dinnerware, ovenware, and teapots. The city also makes potters' supplies and sewer pipes. East Liverpool has a mayor-council government. JAMES H. RODABAUGH

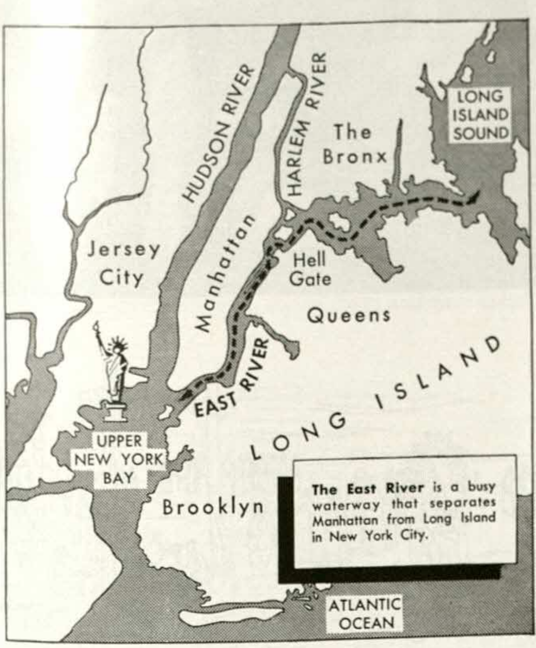
EAST ORANGE, N.J. (pop. 77,259; alt. 175 ft.), is a residential suburb of Newark and New York City. East Orange is the largest of a group of cities called "The Oranges" (see NEW JERSEY [map]). The other "Oranges" are Orange, West Orange, and South Orange. Factories in East Orange make dynamos and other electrical appliances, sewer pipes, airplane parts, machine tools, valve fittings, and waterworks supplies. East Orange Township was separated from Orange Township in 1863. East Orange became a city in 1899. It has a mayor-council government. RICHARD P. MCCORMICK

EAST RIVER, a 16-mile strip of water, connects Long Island Sound and Upper New York Bay. The Harlem River and Spuyten Duyvil Creek join the East River with the Hudson River.

In 1876, engineers blasted out a huge rock that blocked the channel at Hell Gate, the waterway between Ward's Island and the borough of Queens. This allowed large ships to sail the East River channel.

The East River separates the boroughs of Brooklyn and Queens from Manhattan and the Bronx. Seven great bridges cross the river within the city. These are the Brooklyn, Williamsburg, Manhattan, Queensboro, Hell Gate, and two units of Triborough bridges. There are also 11 tunnels for subway, railroad, and vehicular traffic. Brooklyn Naval Shipyard covers 290 acres on the bank of the East River opposite Welfare Island.

New York Harbor includes the lower section of East River. Shipping piers for ocean-going freight vessels lie along the river. Most passenger ships dock on the Hudson River, across Manhattan Island from the East River. WILLIAM E. YOUNG



The East River is a busy waterway that separates Manhattan from Long Island in New York City.

EAST SAINT LOUIS, Ill. (pop. 81,712; alt. 420 ft.), is a manufacturing and railroad center. It stands on the east bank of the Mississippi River, opposite St. Louis, Mo. For location, see ILLINOIS (color map). Two bridges, the Eads Bridge and the Saint Louis Municipal Bridge, connect the cities (see EADS BRIDGE).

The city stands on an area of the Mississippi flood plain known as the American Bottom. For a number of years, East Saint Louis suffered frequent damage from floods. One attempt to defend the city against high waters included grading the main streets to 8 to 15 feet above the flood plain. Today, the city has a 44-foot-high levee and a system of canals to protect it.

The East Saint Louis stockyards are among the largest in the country. Barge lines on the river, about 25 railroad lines, an airport, bus lines, and many important highways serve the city. The East Saint Louis factories turn out a large variety of products, including foods, railroad equipment, building materials, chemicals, steel, and aluminum products.

East Saint Louis is the home of Parks College of Aeronautical Technology, part of St. Louis University. The first Catholic church in the Northwest Territory is in the city.

The area was named Illinoistown in 1816. Its name was changed to East Saint Louis during the 1860's. In 1896, a cyclone swept through it, killing over 100 people and causing extensive damage. East Saint Louis has a commission form of government. PAUL M. ANGLE

EAST STROUDSBURG STATE COLLEGE is a coeducational school at East Stroudsburg, Pa. Courses in education, mathematics, physical education, and science lead to B.S. degrees. The school was founded in 1893. For enrollment, see UNIVERSITIES AND COLLEGES (table).

EAST TENNESSEE STATE COLLEGE is a coeducational state-controlled school at Johnson City, Tenn. It offers arts and sciences, business, nursing education, and teacher training courses leading to bachelor's and master's degrees. The college was founded in 1909 and took its present name in 1943. For enrollment, see UNIVERSITIES AND COLLEGES (table).

EAST TEXAS BAPTIST COLLEGE is a coeducational liberal arts college at Marshall, Tex. It is affiliated with the Southern Baptist Church. Founded in 1914, it offers courses leading to B.A., B.S., and B.Mus. degrees. For enrollment, see UNIVERSITIES AND COLLEGES (table).

EAST TEXAS STATE COLLEGE is a coeducational state-controlled college at Commerce, Tex. Courses in about 30 major departments lead to bachelor's and master's degrees. The college has a summer session, as well as an extension division, and operates on a 12-month basis. It was founded in 1889 as East Texas Normal College. It became a state school in 1917, and took its present name in 1957. For enrollment, see UNIVERSITIES AND COLLEGES (table). JAMES G. GEE

EASTER is a Christian festival that celebrates the resurrection of Jesus Christ. It is the most important holy day of the Christian religion. People attend churches and take part in religious ceremonies.

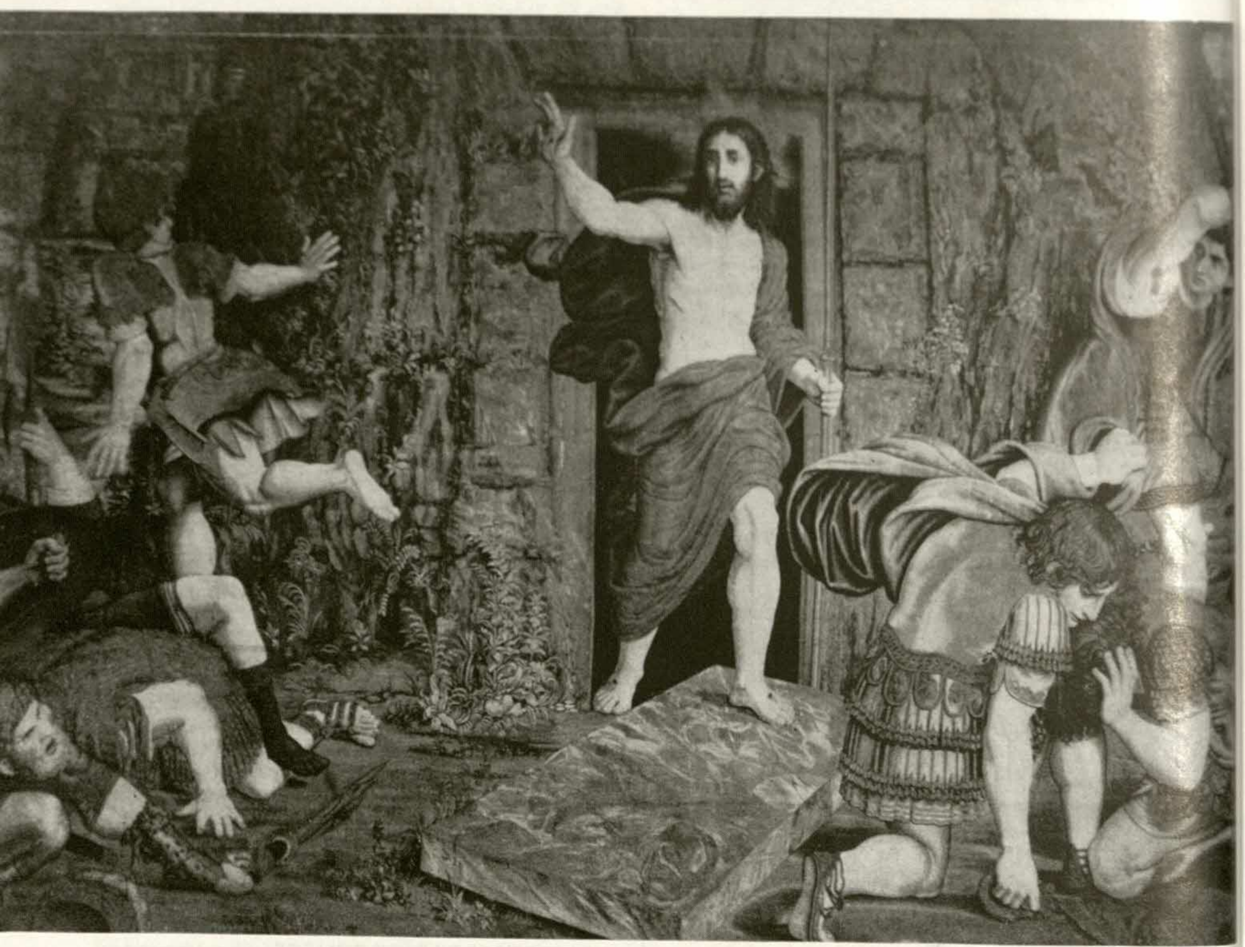
In most countries, Easter comes in early spring, at a time when green grass and warm sunshine begin to push aside the ice and snow of winter. Its name may have come from *Eostre*, a Teutonic goddess of spring, or from the Teutonic festival of spring called *Eastur*. Most Christians observe Easter on a Sunday between March 22 and April 25. Members of Eastern Orthodox churches sometimes celebrate it later than other churches do.

The story of Easter comes from the Bible. The Gospels tell that the body of Jesus disappeared from His tomb on the third day after His crucifixion. An angel appeared to His followers and announced, "He is risen."

Christians everywhere celebrate Easter with great rejoicing. In many areas, children collect candy and chocolate bunnies, and hunt colorful Easter eggs. Many persons wear new spring clothes to church on Easte

Easter Symbols

The Cross represents the crucifixion of Jesus Christ. It has special meaning to Christians as a symbol of



Camera Clix

On Easter Sunday, Christians celebrate the resurrection of Jesus Christ. They honor the day when He triumphed over death. The crucifixion, *right,* had seemed a dark day. Crowds gathered on the hill, called Golgotha or Calvary, overlooking the city of Jerusalem. But at the resurrection, shown in a tapestry, *above,* designed by Raphael, Christ brought promise of a new life to come for all men.

Wide World

Sunrise Services mark the dawn of Easter in many parts of the world. Thousands gather in the Theater of the Red Rocks near Denver, Colo. Other famous sunrise services take place in the Hollywood Bowl at Hollywood and in the Hawaiian Punchbowl, near Honolulu.

Christ's victory over death. The cross often appears as an Easter symbol. People in many parts of the world eat special cakes called *hot cross buns* during the Easter season. Each cake has a cross of icing on its crust. The Greeks and Portuguese eat a specially baked round, flat Easter loaf marked with a cross and decorated with Easter eggs.

The Lamb. Easter decorations and paintings often include the figure of a lamb as a symbol of Jesus. Lamb is one of the traditional Easter foods, and cookies and cakes shaped like lambs decorate many tables at Easter time.

The symbol of the lamb comes from the Jewish *Pesah*, or Passover, holiday (see PASSOVER). The Jews sacrificed a lamb, called a *paschal* lamb, during their traditional Passover ceremony in the Temple in Jerusalem. Early Christians interpreted the sacrifice of the paschal lamb as a forecast of Christ's sacrifice on the cross. They spoke of Jesus as "the Lamb of God, which taketh away the sin of the world" (John 1: 29).

Lights, candles, and bonfires mark Easter celebrations in some lands. Roman Catholics in some countries put out all the lights of their churches on Good Friday. On Easter Eve, they make a new fire to light the main *paschal candle*, or Easter candle. They use this candle to relight all the candles in the church. Then they light their own candles from the great paschal candle, and carry them home to be used on special occasions.

In many parts of northern and central Europe, people burn bonfires on the hilltops. Then they gather around the bonfires and sing Easter hymns.

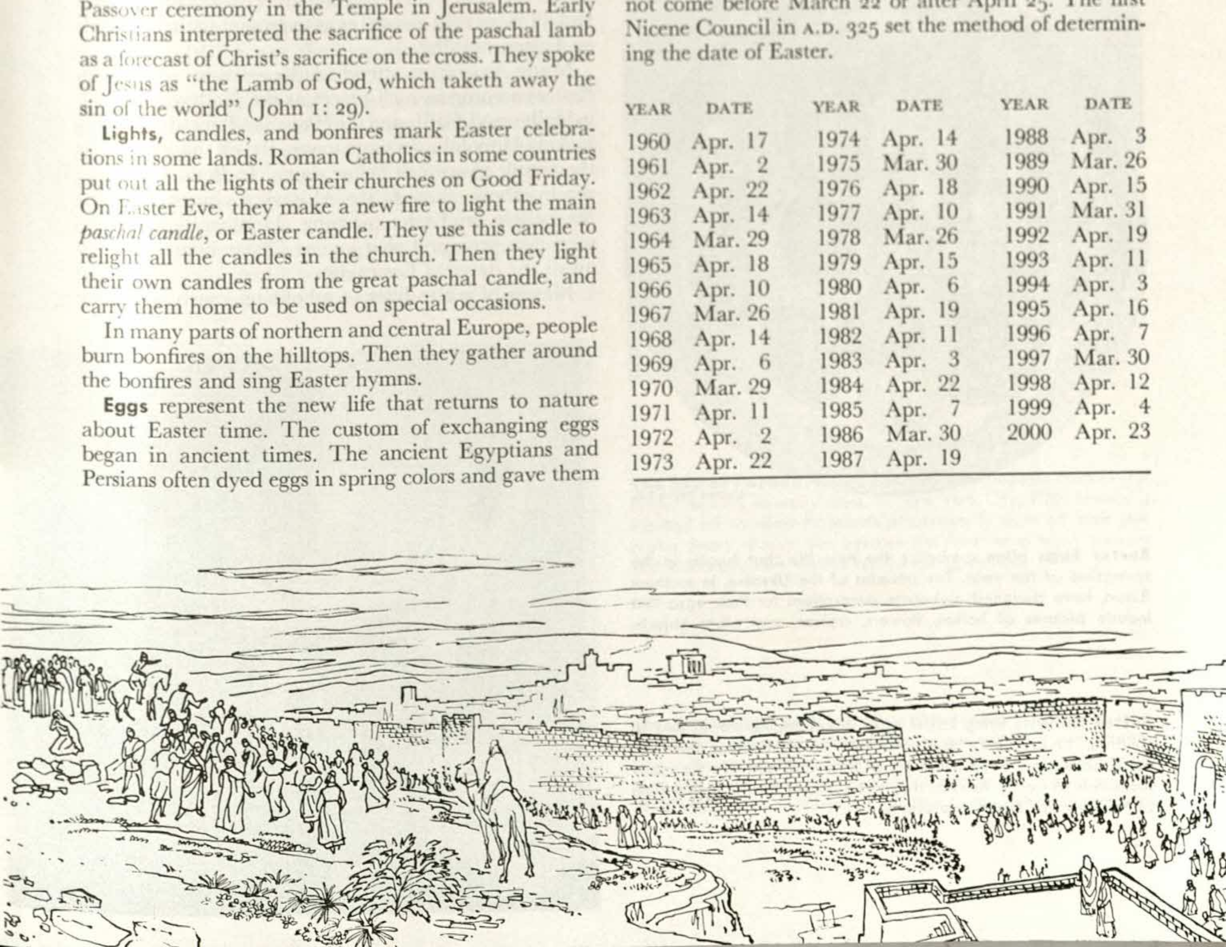
Eggs represent the new life that returns to nature about Easter time. The custom of exchanging eggs began in ancient times. The ancient Egyptians and Persians often dyed eggs in spring colors and gave them to their friends as gifts. The Persians believed that the earth had hatched from a giant egg.

Early Christians of Mesopotamia were the first to use colored eggs for Easter. In some European countries, people colored eggs red to represent the joy of the resurrection. In England, friends often wrote messages and dates on the eggs they exchanged. Elaborate candy eggs with a window in one end and tiny scenes inside were popular gifts in the 1800's. Children today often find chocolate eggs or cardboard eggs filled with candy

DATES OF EASTER, 1960-2000

Easter is one of the movable feasts of the Christian religion. Its date varies each year, but it falls on the first Sunday after the first full moon after March 21. It cannot come before March 22 or after April 25. The first Nicene Council in A.D. 325 set the method of determining the date of Easter.

YEAR	DATE	YEAR	DATE	YEAR	DATE
1960	Apr. 17	1974	Apr. 14	1988	Apr. 3
1961	Apr. 2	1975	Mar. 30	1989	Mar. 26
1962	Apr. 22	1976	Apr. 18	1990	Apr. 15
1963	Apr. 14	1977	Apr. 10	1991	Mar. 31
1964	Mar. 29	1978	Mar. 26	1992	Apr. 19
1965	Apr. 18	1979	Apr. 15	1993	Apr. 11
1966	Apr. 10	1980	Apr. 6	1994	Apr. 3
1967	Mar. 26	1981	Apr. 19	1995	Apr. 16
1968	Apr. 14	1982	Apr. 11	1996	Apr. 7
1969	Apr. 6	1983	Apr. 3	1997	Mar. 30
1970	Mar. 29	1984	Apr. 22	1998	Apr. 12
1971	Apr. 11	1985	Apr. 7	1999	Apr. 4
1972	Apr. 2	1986	Mar. 30	2000	Apr. 23
1973	Apr. 22	1987	Apr. 19		



at the breakfast table on Easter morning. See CZECHOSLOVAKIA (picture, Dyeing Easter Eggs).

Rabbits. Many children believe that an Easter bunny brings their Easter eggs. This belief probably comes from Germany. One legend says that a poor woman dyed some eggs during a famine, and hid them in a nest as an Easter gift for her children. Just as the children discovered the nest, a big rabbit leaped away. The story spread that the rabbit had brought the Easter eggs.

In ancient Egypt, the rabbit symbolized birth and new life. Some ancient peoples considered it a symbol of the moon. It may later have become an Easter symbol because the moon determines the date of Easter.

Easter Around the World

Christians in many parts of the world celebrate before the Easter season with carnivals, masquerades, and feasts. These celebrations reach a peak of gaiety on Shrove Tuesday, more than six weeks before Easter. On Ash Wednesday, the day after Shrove Tuesday, many Christians start a solemn 40-day period of fast and prayer called *Lent.* It recalls Christ's 40-day fast in the wilderness.

The last week of Lent, called Holy Week, honors the events of the last week of Christ's life on earth. It begins on Palm Sunday, named for the palms that people spread before Jesus as He entered Jerusalem in triumph. On the Thursday of the last week of Lent, Maundy Thursday, Christians recall Jesus' Last Supper and the time He washed His disciples' feet. They observe Good Friday, the day of Christ's crucifixion, in a somber manner, and spend Holy Saturday in anticipation. On Easter Sunday, millions of Christians in all parts of the world unite in their feelings of joy in the resurrection of Jesus Christ.

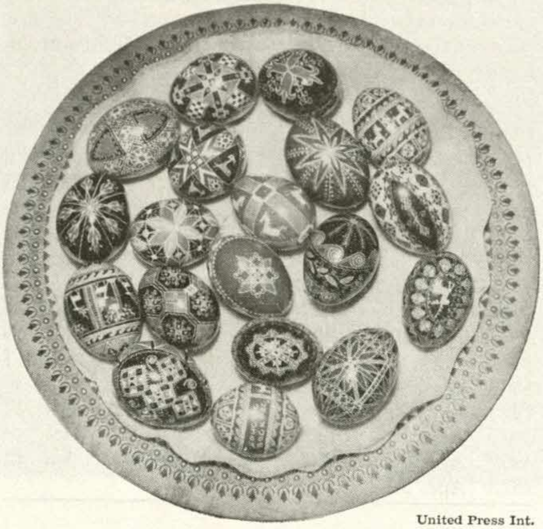
Many customs connected with the Easter season come from pagan festivals of spring. Others stem from the Passover celebration. The name for Easter in some languages comes from the Hebrew Pesah. The Italians call Easter *Pasqua;* the Spaniards, *Pascua;* and the French, *Pâques.*

In the United States, some cities celebrate Shrove Tuesday with merriment and feasting. New Orleans stages its world-famous Mardi Gras from about January 6 to Shrove Tuesday (see MARDI GRAS). Many persons travel to New Orleans to enjoy the costume balls, parades, and gay celebrations. People in some parts of the country call Shrove Tuesday *Pancake Day.* They follow an old English custom of eating pancakes on this day. Women in Olney, England, have a pancake race on Shrove Tuesday. Each woman carries a griddle with a hot pancake on it, and must flip the pancake at least three times during the race. The women compete with the women of Liberal, Kan., in an annual race held in both towns.

Many children and adults enjoy painting and dyeing eggs at Easter time. Some children paint faces on their eggs and dress them in funny paper hats. Others cover their eggs with flowers, cellophane, or ribbon, or write names on them. School children may make large baskets and fill them with colored eggs to present to their parents on Easter morning.

Many Americans attend outdoor sunrise services on Easter morning in such places as the Hollywood Bowl, in Hollywood, Calif., and the Hawaiian Punchbowl, overlooking Honolulu. In some towns, the church choir calls the people to services before dawn. In Bethlehem, Pa., the trombone choir of the Moravian church awakens the people on Easter morning. Members of the congregation pray and sing joyous Easter hymns as they await the dawn of Easter day.

Masses of white lilies, symbolizing purity, decorate



United Press Int.

Easter Eggs often symbolize the new life that begins in the springtime of the year. The peoples of the Ukraine, in southern Russia, have designed elaborate decorations for their eggs that include pictures of horses, flowers, crosses, and other objects.

H. Armstrong Roberts

Easter Rabbits bring Easter eggs, according to stories told to children. This idea may have come from an old German folk tale. But rabbits have been a symbol of birth and new life for many thousands of years. As such, they are symbols for the celebration of the new life Easter represents.

the altars of churches throughout the country. People usually wear new spring clothes to church. Many women buy special "Easter bonnets" to wear at the afternoon fashion parades on Fifth Avenue in New York City and on the Boardwalk of Atlantic City, as well as on the main streets of many cities and towns. One of the most beloved popular songs is "Easter Parade," by Irving Berlin.

Young people often have parties on Easter afternoon. They decorate place cards, napkins, and party favors with bunnies, chickens, and eggs. The parties usually feature Easter egg hunts. Each young guest receives a basket and hunts Easter eggs that adults have hidden around the house. The child who gathers the most eggs in his basket wins a prize. On the Monday after Easter, the President of the United States welcomes thousands of children to the White House lawn in Washington, D.C., for an egg-rolling contest. See EASTER EGG ROLLING.

In Great Britain, housewives bake hot cross buns on each Friday during Lent. Many persons eat *carlings*, or peas, on Carling Sunday, the fifth Sunday in Lent. People in Lancashire enjoy fig pies on this day. The English like to buy new clothes for Easter Sunday. An old English rhyme says, "At Easter let your clothes be new, or else be sure you will it rue."

The meanings of some old English customs have been lost through the years. In early days, boys and girls, dressed in their best Easter clothes, enjoyed *clipping the church* on Easter Sunday. They formed a circle around the church with their backs to it. By joining hands, they *clipped*, or embraced, the church.

People in Ireland dance on Easter day to win prize cakes. The Irish break the long fast of Lent by eating eggs at dawn on Easter.

In Belgium and France, mothers sometimes tell their children that the Easter chimes bring their eggs. Belgian children like to make nests of hay and hide them in the grass for the Easter bunny to fill. In France and some other European countries, church bells do not ring from Good Friday to Easter. One legend says that the bells fly to Rome until Easter, and drop eggs on the way back for boys and girls to find.

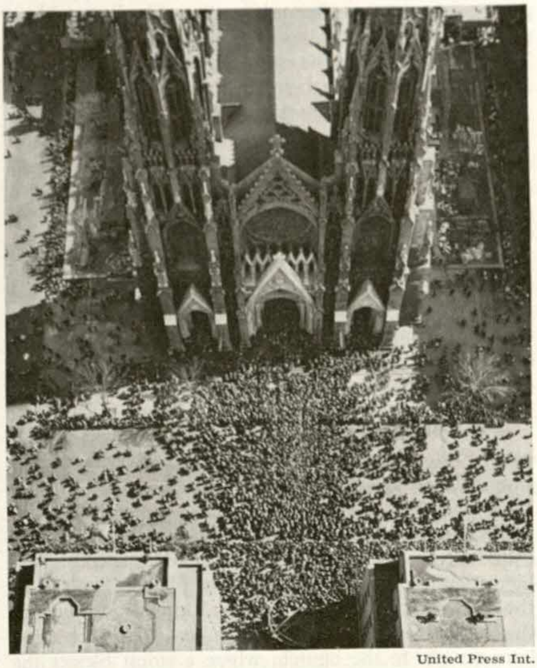
In Germany, people call the Shrove Tuesday festival *Fastnacht*, or fast night. They eat cakes, also called *fastnachts*, and pretzels. The Swiss make their fastnachts with caraway seeds.

Germans color eggs green on Green Thursday (Maundy Thursday). They carry the eggs with them all day for good luck. German children believe that the Easter rabbit hides the eggs they find in their gardens. On Easter Monday, the young people have an egg-rolling contest called *Eierlesen*. The winner gets a prize of 101 eggs.

In Italy, a priest blesses the Easter eggs before the holiday. Housewives place the eggs at the center of the Easter table and arrange other foods around them. A family may have as many as 200 brightly colored eggs in the centerpiece. Many Italians eat Easter cakes baked in the shape of rabbits.

Thousands of worshipers make pilgrimages to Rome for Holy Week services in St. Peter's Church. People in

Wide World



United Press Int.

The Easter Parade, *above*, has become a popular tradition for Easter Sunday in many cities. In New York City, Fifth Avenue is blocked off to allow thousands of persons to show off their new Easter finery. Easter has become the time when many persons first wear their new clothes for the spring season.

The Easter-Egg Roll, *left*, takes place on the White House lawn on the Monday after Easter. Children are admitted freely to the egg-rolling race. Adults must be accompanied by children before they may enter the area. In 1878, Rutherford B. Hayes was the first President to welcome the children to the White House lawn.

Florence celebrate Holy Saturday, the Saturday before Easter. They decorate a cart with flowers and fireworks. Two white oxen draw the cart through the streets and stop before the door of the cathedral. There a wire connects the cart to the altar of the church. Suddenly a lighted firecracker shaped like a dove speeds along the wire to the cart. It ignites the fireworks in the cart, then travels back along the wire to the church. The people consider it a good omen if the "dove" completes its trip before the fireworks explode.

In Spain, cities and towns hold religious processions on Good Friday. In some places, the processions feature *pasos*, or wooden images mounted on platforms. Each platform represents a scene from the last week in the life of Christ. The Spaniards dance to gay music on Easter day, and often watch bullfights.

In The Netherlands, young people in the villages form processions on Easter Eve. They sing Easter songs and carry lighted lanterns as they wind their way to the market place for music and dancing. On Easter Monday, young and old alike play games involving eggs. The children collect the eggs from door to door during Holy Week, the week before Easter.

In Scandinavian Countries, people often spend the Easter holidays in the mountains for winter sports and skiing. They gather for outdoor services on Easter morning. On Shrove Tuesday, children in Denmark and Norway trim birch branches with gay paper streamers. They "beat" adult members of the family with these *Lenten birches* until they receive "payments" of hot cross buns. Children in Finland perform this ritual on Holy Saturday and receive Easter eggs. The Finns eat traditional Easter cakes made with rye meal and baked in birch baskets. Swedish families decorate their houses during Lent with birch twigs trimmed with chicken feathers.

In Greece and Romania, people tap red eggs together as an Easter greeting when they meet. The first person says, "Christ is risen," and the other replies, "Truly, He is risen."

On Good Friday, the Greeks take part in a ceremony called *Epitaphios*, or *Burial of Christ*. Four men carry a bier containing a wooden figure of Christ. The rest of the congregation forms a funeral procession behind them and marches through the streets. The procession later returns to the church, where a priest blesses the candles and flowers and distributes them to the congregation. On Easter Monday, the Greeks dress in their traditional national costumes and enjoy music and dancing.

On Easter Eve in Romania, churchgoers carry lighted candles home from midnight mass. When they reach home, the young people gaze into mirrors by the light of the candles to try to see into the future.

In Poland and Bulgaria, a priest blesses the Easter food. On Holy Saturday, Bulgarians exchange eggs and baked almond cakes that the priest has blessed. In Poland, the priest visits the homes in his parish to bless the food the people will serve on Easter. The Poles call this food *hallow-fare*, or blessed food. It must last through Easter Sunday, because they do not cook anything on that day.

In the Ukraine, people celebrate Easter for two weeks. They observe Holy Week with reverence, and celebrate the week after Easter with entertainment and dancing. The Ukrainians are famous for their beautifully decorated Easter eggs. Each village makes its own design. The designs include fir trees, priests' robes, bell towers, and chapels. Ukrainians often cast eggshells on the waters of streams to show the dead that it is Easter. Ukrainian girls like to make their cheeks glow by rubbing them with eggs dyed red.

In Hungary, young people play a game with fire called *sajbozas* on the first Sunday night of Lent. Girls set fire to a small hut built for the occasion in an open field. The boys then heat *sajbo* rings in the flames. They twirl the hot rings on the ends of sticks and send them flying through the darkness. The rings look like pinwheels in a fireworks display. On Easter Monday, the boys sprinkle the girls with perfumed water and receive Easter eggs as rewards.

In Mexico, at noon on the day before Easter, thousands of persons fill the streets. They beat, hang, and burn images of Judas Iscariot, who betrayed Christ. In many places, the Judas figure is a *piñata*, a jar filled with candy. The jar breaks and scatters the candies, to the delight of the children.

In the Middle East. Armenian and Syrian churches hold foot-washing ceremonies on Maundy Thursday. Church officials invite beggars inside, wash their feet, and give them gifts in memory of Christ, who washed His disciples' feet. In Jerusalem, the patriarchs and bishops of the Eastern Orthodox churches, who represent the twelve disciples, take part in a public foot-washing ceremony. Armenians celebrate Easter Monday as a *Feast of the Dead*. They take food to the cemeteries, where priests bless it.

ELIZABETH HOUGH SECHRIST

Related Articles in WORLD BOOK include:

Ash Wednesday
Easter Lily
Good Friday
Holy Week
Jesus Christ
Lent
Maundy Thursday
Palm Sunday
Paschal Candle
Resurrection
Shrove Tuesday

Outline

I. Easter Symbols
- A. The Cross
- B. The Lamb
- C. Lights
- D. Eggs
- E. Rabbits

II. Easter Around the World
- A. In the United States
- B. In Great Britain
- C. In Belgium and France
- D. In Germany
- E. In Italy
- F. In Spain
- G. In The Netherlands
- H. In Scandinavian Countries
- I. In Greece and Romania
- J. In Poland and Bulgaria
- K. In the Ukraine
- L. In Hungary
- M. In Mexico
- N. In the Middle East

Questions

Why is Easter a joyous holiday for Christians?

What is the origin of (1) the Easter bunny? (2) the cross? (3) Easter eggs?

What ceremony is practiced on Maundy Thursday? Why?

Where does the name *Easter* come from? What does *paschal* refer to?

What are sunrise services?

Who first used colored Easter eggs?

What is *hallow-fare?* Why must it last through Easter Sunday?

What does Palm Sunday celebrate?

How do people observe Lent?

What are *pancake races?* Where do they take place?

EASTER EGG ROLLING is an Easter custom practiced in several countries. The most famous rolling takes place on the White House lawn in Washington, D.C. Thousands of persons gather to roll Easter eggs on the lawn on the Monday after Easter. President Hayes started the custom in 1879. It has been observed ever since, except for the years between 1942 and 1953.

EASTER ISLAND, or **RAPA NUI,** *RAH pah NOO ee,* lies in the South Pacific about 2,400 miles west of Chile. The island is governed by Chile. A Chilean naval vessel stops there once or twice each year. Easter Island is of volcanic origin, and covers about 45 square miles. The island has no streams. However, three extinct volcanoes have crater lakes. The principal volcano rises about 1,400 feet. Weathered lava supports grasses on which the Chilean Navy grazes sheep. Much of the coast is steep, with no reefs and only one sandy beach. For location, see PACIFIC OCEAN (color map).

The entire population of the island has been moved to the small village of Hangaroa on the west coast since the introduction of Christianity in 1868. The population was nearly wiped out in 1862 by a Peruvian slave raid, followed by a smallpox epidemic. However, the Polynesian population has increased and now includes about 3,550 people.

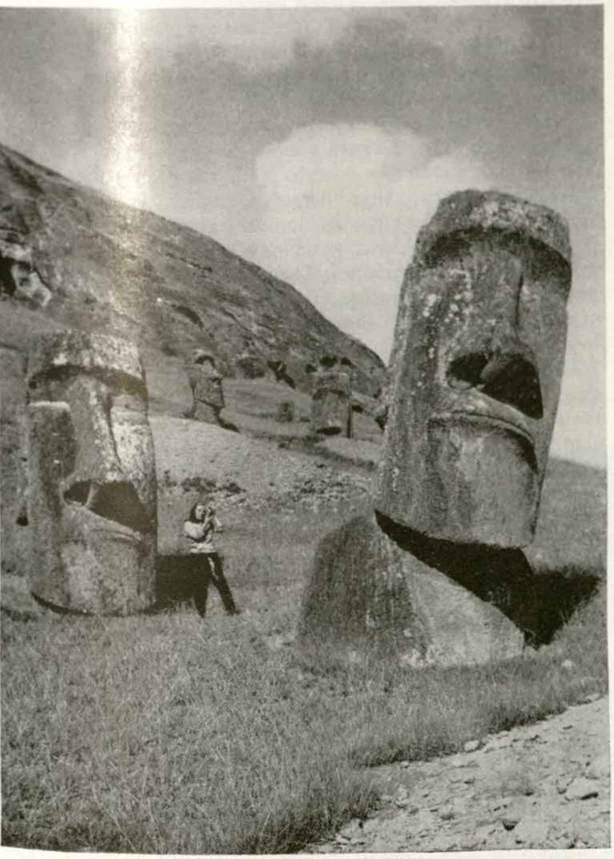
The Dutch Admiral Roggeveen discovered Easter Island on Easter Sunday, 1722. Archaeologists agree that three different cultural ages flourished on the island before the arrival of the Europeans. By A.D. 400, an elaborate defense position had been built by people who specialized in making small stone statues and neatly fitted masonry of large stones. A later civilization destroyed these constructions and rebuilt them to form *ahus,* or raised temple platforms. Gigantic stone busts in human forms were erected on the ahus. During this period, more than 600 large stone statues were carved from hard volcanic rock in the crater walls of the volcano Rano Raraku. The sculptors used stone hand picks made of basalt. Some of the statues measured 30 to 40 feet tall. Hundreds of them were transported to distant parts of the island and erected on top of ahu walls. Huge red stone cylinders were balanced on top of their heads.

The ancestors of the present Polynesian population conquered the island about 1670 and massacred its inhabitants. A period of decline followed, lasting until the 1860's. During this period, all the statues on the ahus were overthrown. Cannibalism was practiced. Many people abandoned their grass houses and lived in underground caves where they stored their treasures. Early missionaries found a number of wooden tablets covered by rows of a kind of script. The inhabitants could not explain the script. About 20 such boards are preserved today in museum collections.

At the time of discovery, the Easter Islanders ate chiefly fish and sweet potatoes. Today they depend on the yearly supplies brought by the Chilean Navy. An airstrip was begun in the late 1950's. THOR HEYERDAHL

The Monstrous, Eyeless Statues on Easter Island have baffled archaeologists for years. More than 600 stone giants, some weighing 60 to 70 tons, have been found on the barren island. Scientists have not as yet determined who carved them.

Rebeca Yañez



EASTER LILY, a flower that has become a sign of Easter, is a tall plant with long pointed leaves. The large, fragrant flowers are a waxy white color, and are shaped like a trumpet.

Many kinds of Easter lilies grow throughout the world. American florists formerly grew the Madonna lily of Southern Europe. Its periods of blooming, however, are not regular. New kinds of Easter lilies have been brought to America from China, Japan, and Bermuda. The Bermuda Easter lily blooms early in the season. The Chinese and Japanese lilies are the hardiest. They bloom outdoors in June or July. Florists can force both the Chinese and Japanese lilies to bloom just before Easter, in hothouses.

Scientific Classification. Easter lilies belong to the family *Liliaceae.* They are genus *Lilium,* species *longiflorum.* ALFRED C. HOTTES

See also FLOWER (color picture, Flowers in Festivals and Customs); LILY; PLANT (color picture, Some Members of the Lily Family).

EASTER REBELLION. See IRELAND (History).

EASTERN AIR LINES. See AIRLINE.

EASTERN BAPTIST COLLEGE is a coeducational liberal arts school at St. Davids, Pa. A strong Christian emphasis is placed on its courses. Graduates receive A.B. degrees. Its beautiful campus, which contains three lakes, also has a nationally publicized water wheel. The college was founded in 1932 by the Eastern Baptist Theological Seminary, and chartered in 1952. For enrollment, see UNIVERSITIES AND COLLEGES (table).

EASTERN BAPTIST THEOLOGICAL SEMINARY is a coeducational school at Philadelphia, Pa. Related to the Baptist Church, it has a Divinity School, and a School of Christian Education. The seminary grants A.B., Th.M., and M.R.E. degrees. It was founded in 1925 by a group of Baptist ministers. For enrollment, see UNIVERSITIES AND COLLEGES (table).

EASTERN EMPIRE. See BYZANTINE EMPIRE.

EASTERN HEMISPHERE. See HEMISPHERE.

EASTERN ILLINOIS UNIVERSITY is a coeducational state-controlled university at Charleston, Ill. Courses lead to bachelor's degrees, and the master of education degree. The university was established in 1895. For enrollment, see UNIVERSITIES (table).

EASTERN KENTUCKY STATE COLLEGE is a coeducational liberal arts school at Richmond, Ky. Courses lead to bachelor's and master's degrees. There is a summer session, as well as an extension division. Eastern Kentucky was founded in 1906 by the state legislature. For enrollment, see UNIVERSITIES AND COLLEGES (table).

EASTERN MICHIGAN UNIVERSITY is a state-controlled, coeducational school at Ypsilanti, Mich. Courses in liberal arts, education, special education, and business administration lead to bachelor's and master's degrees. The university, founded in 1849, includes the Horace Rackham School of Special Education. For enrollment, see UNIVERSITIES AND COLLEGES (table).

EASTERN MONTANA COLLEGE OF EDUCATION is a coeducational, state-controlled school at Billings, Mont. Courses lead to bachelor's and master's degrees in education. The college, founded in 1925, offers a special program to train teachers of handicapped students. For enrollment, see UNIVERSITIES (table).

EASTERN NAZARENE COLLEGE is a coeducational liberal arts school at Wollaston Park, Quincy, Mass., maintained by the Church of the Nazarene. Pre-engineering and premedical work, and nurses' and teachers' training are given. It has a graduate school of theology. It was originally founded as a Bible school in 1900. For enrollment, see UNIVERSITIES (table). EDWARD S. MANN

EASTERN NEW MEXICO UNIVERSITY is a state-controlled coeducational school at Portales, N.M. Courses in business and economics, music, teacher education, technology, and liberal arts lead to A.B., B.S., M.A., and M.S. degrees. The university was founded in 1934. The first all-college rodeo in the United States was held there in 1935. For enrollment, see UNIVERSITIES AND COLLEGES (table). FLOYD D. GOLDEN

EASTERN OREGON COLLEGE is a coeducational liberal arts teacher-training school at La Grande, Ore. The college grants bachelor's and master's degrees. Two-year courses are given in secretarial science, merchandising, and work as medical and dental assistants. The college was founded in 1929. For enrollment, see UNIVERSITIES AND COLLEGES (table).

EASTERN ORTHODOX CHURCHES are the major Christian churches in Eastern Europe, Asia, and Egypt. The federation of Eastern Orthodox Churches is made up of 19 independent churches united by common beliefs, doctrines, and traditions. The federation is sometimes spoken of as the Greek Church. About 250,000,000 persons belong to the Orthodox churches, which have many branches in the United States, Canada, and Western Europe.

Religious News Service

Eastern Orthodox Churches, such as St. Sophia's Cathedral in Los Angeles, show the influence of Byzantine architecture.

Teachings. Members of the Eastern Orthodox Churches believe that they continue the tradition of the early Christian church founded by the apostles. Their faith is based on the doctrinal decisions of the seven *ecumenical councils*, or those councils that governed the entire church. The last such council was held in 787. The Orthodox churches consider as binding only the Nicene-Constantinopolitan Creed, adopted at the Council of 381. The churches do not acknowledge the pope's claim to *primacy of jurisdiction*, or religious control over Christian churches. They do grant the pope primacy of honor. But they refuse to accept the dogma of *papal infallibility*, or the pope's freedom from error in matters concerning faith and morals.

Organization. The Orthodox group forms a federation of independent churches that are self-governing in their internal affairs. The churches conduct their worship in their own languages and follow their own customs and traditions. The patriarchate at Constantinople has the honor of first rank among the churches, but it does not rule over or control them. The *parochial*, or parish, priests of the Orthodox churches may marry. The *episcopacy*, or bishops, may not marry. Bishops are chosen from among the monks. Some groups of Orthodox Christians have acknowledged the control of the pope at Rome. They are united with the Roman Catholic Church and are known as *uniate churches*. But they keep the Eastern rite, and their priests may marry.

History. Originally, Christendom was divided among three *patriarchates*, or ruling divisions, centered around Rome, Alexandria, and Antioch. In A.D. 330, Constantine removed the capital of the empire from Rome to Constantinople (now Istanbul). By 381, the new capital was made second in importance only to Rome.

This produced jealousy among the older Eastern divisions, particularly in Alexandria. A struggle for control took place between Alexandria and Constantinople. Constantinople won the contest at the Council of Chalcedon in 451, and was given patriarchal rank. Jerusalem became the fifth patriarchate at the same time.

Alexandria broke away from the imperial church as a result of the Chalcedon decisions. The Alexandrian church exists to this day as a separatist Coptic church (see Copts). It was followed by its daughter church in Ethiopia, and then by the Syrian National, Nestorian, and Armenian churches.

Rome and Constantinople remained as the two largest patriarchates. Rome soon claimed supreme jurisdiction over all Christendom. This was the real meaning of the *Photian schism*, or break, which occurred in the 800's (see Photius). Further political, racial, and religious rivalries resulted in the final schism between East and West in 1054.

The Crusades and invasions by the Turks weakened Constantinople and the Byzantine Empire. The Fourth Crusade of 1204 resulted in the conquest of Constantinople and much of its empire. Constantinople finally fell to the Turks in 1453. The leadership of the Byzantine church gradually passed to the Russian church.

The patriarchate of Constantinople exercised supreme authority over most of the Orthodox population of the Ottoman Empire until the 1800's. Then it lost much of its territory as a result of the rise of the free Balkan states. The Church of Greece proclaimed itself free in 1830. Serbia obtained a self-governing church in 1832, and full independence in 1878. The Romanian church became self-governing in 1865, and was acknowledged as such by the patriarchate in 1885. The Bulgarians set up a national church in 1872. It was declared schismatic, but the patriarchate recognized it in 1945.

After World War I, new Orthodox churches were organized in Poland, Czechoslovakia, and Albania. The once-separated Romanian churches were united into one body. The same happened in Yugoslavia, where the once-separated churches united to form the National Serbian Orthodox Church. The patriarchate of Constantinople lost a large share of its territory. Now it is limited only to the city and its suburbs. Antony Bashir

For membership in the United States, see Religion (table). See also National Council of the Churches of Christ in the United States of America; Nicene Councils; Religion (color picture, Eastern Orthodox Christianity); World Council of Churches.

EASTERN STAR, ORDER OF THE, is a fraternal organization of Master Masons and their wives, widows, mothers, daughters, and sisters. It works to promote charity, good will, and social enjoyment, and supports social and charitable projects. All chapters are organized under the General Grand Chapter, founded in 1876. The Eastern Star has about 3,000,000 members in 14 countries. Headquarters are located at 1618 New Hampshire Ave. N.W., Washington 9, D.C. See also Masonry. Critically reviewed by Order of the Eastern Star

EASTERN TIME. See Standard Time.

EASTERN WASHINGTON COLLEGE OF EDUCATION is a coeducational, state-controlled school at Cheney, Wash. Courses in liberal arts and education lead to B.A., B.A. in Ed., and M.S. in Ed. degrees. The college was founded in 1890 as Cheney Normal School. For enrollment, see Universities and Colleges (table).

EASTLAND, JAMES O. See Mississippi (Famous Mississippians).

EASTMAN, CHARLES ALEXANDER. See Minnesota (Famous Minnesotans).

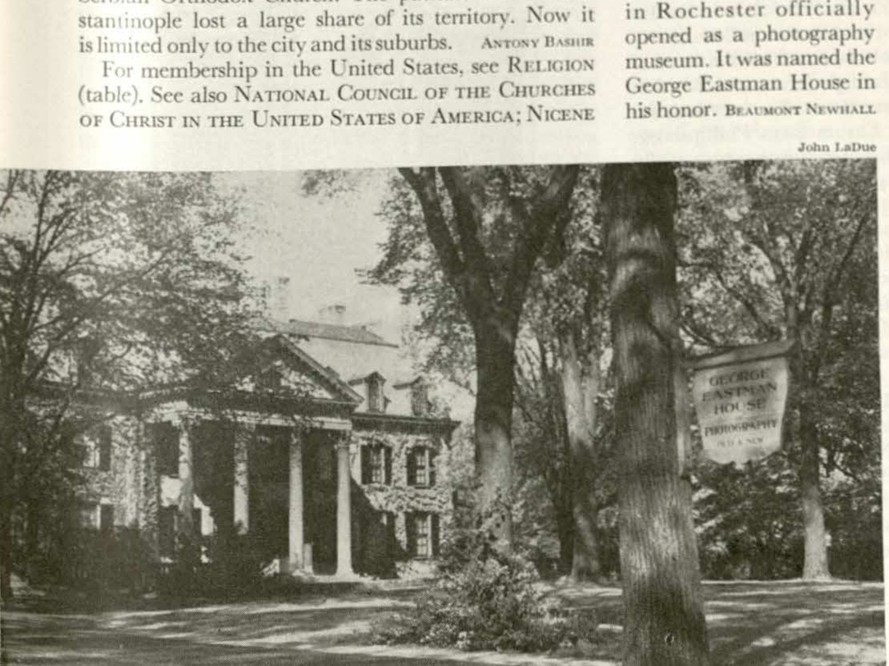
EASTMAN, GEORGE (1854-1932), an American manufacturer, made it possible for millions of persons to become amateur photographers. In 1879, he invented and patented a machine for coating the glass plates used in cameras. He went into the photographic-plate-making business with Henry A. Strong in 1880. Four years later, he perfected flexible roll films and designed the roll holder for winding them. By 1888, he had produced a light camera, the *Kodak*, priced at $25. He had a dollar camera on the market by 1900.

Eastman was born July 12, 1854, at Waterville, N.Y. He established his factory in Rochester, N.Y. He made philanthropic gifts totaling more than $100,000,000. These included large sums to the Massachusetts Institute of Technology, the University of Rochester, and the Eastman School of Music (see Eastman School of Music). In 1949, his home in Rochester officially opened as a photography museum. It was named the George Eastman House in his honor. Beaumont Newhall

N. E. Luboshez, Eastman Kodak

George Eastman

John LaDue



The George Eastman House in Rochester, N.Y., opened as a museum of photography in 1949. It has exhibits of antique cameras, historic photographs, and dioramas on the history of photography.

EASTMAN, MAX FORRESTER (1883-), is an American writer whose *Enjoyment of Poetry* (1913) introduced many readers to poetry. As a strong Marxian socialist, he helped found the magazines *The Masses* (1911) and *The Liberator* (1919). But in 1955, he turned against socialism in *Reflections on the Failure of Socialism.* He also wrote *Enjoyment of Laughter* (1936) and *Enjoyment of Living* (1947), which tells how he left orthodox religion and took up socialism. Eastman was born at Canandaigua, N.Y. Both of his parents were ordained preachers. EDWIN H. CADY

EASTMAN KODAK COMPANY is one of the world's largest manufacturers of photographic equipment. Its products include photographic film, paper, chemicals, cameras, camera parts and equipment, and optical goods. The company is also a large producer of nonphotographic goods, such as textiles, plastics, and commercial chemicals. George Eastman founded the company in 1880 as a result of his interest in making amateur picture-taking easier and less expensive. Eastman revolutionized photography in 1885 when he introduced roll film which used a paper base instead of glass. The company marketed its first camera in 1888, and in 1889 it introduced the first flexible, transparent roll film for commercial purposes. During World War II, Eastman Kodak operated a school of aerial photography to train servicemen. Company headquarters are in Rochester, N.Y. See also MANUFACTURING (table, 100 Leading Manufacturers).

EASTMAN SCHOOL OF MUSIC, a division of the University of Rochester, is one of the most noted music schools in the United States. It was founded in 1921. George Eastman, camera manufacturer, provided the new building at a cost of nearly $3,000,000. Later Eastman established an endowment of $10,000,000, and gave funds for three other buildings and a dormitory. The standard departments of music are taught, and a summer session is held. The school presents an annual festival of American music in Rochester. See also EASTMAN, GEORGE. C. C. RIKER

EASTON, Pa. (pop. 31,955; alt. 365 ft.), is in the industrialized area known as the Allentown-Bethlehem-Easton Metropolitan District. It lies 70 miles west of New York City where the Lehigh River and Bushkill Creek flow into the Delaware River. For location, see PENNSYLVANIA (color map). Easton faces Phillipsburg, N.J., and with this town forms one community, socially and economically. Easton produces cement, textiles, pencils and crayons, paper products, transformers and coils, and various special machinery. The Easton site was surveyed in 1752 by order of Thomas Penn, son of William Penn. Delaware Indians called the land *Lechanwitauk*, meaning *place at the forks*. Easton became a city in 1887. It is the home of Lafayette College. Easton has a mayor-council government. S. K. STEVENS

EATING. See FOOD.

EATON, DORMAN BRIDGMAN. See ARTHUR, CHESTER ALAN (The Civil Service Act).

EATON, PEGGY. See O'NEALE, MARGARET.

EATON, THEOPHILUS (1590-1658), a Puritan founder of New Haven colony, sailed from England for Boston in 1637 with a company of 250. The colonists were invited to settle in Massachusetts, but the controversy over Anne Hutchinson was raging there, and news from England suggested that the colony might lose its charter (see HUTCHINSON, ANNE MARBURY). Most important, Eaton, a wealthy merchant, wanted a good harbor for trade.

He and his friends left Boston, and in 1638 settled New Haven. They purchased land from the Indians, and organized a church and court. Eaton was elected governor in 1639, and ruled almost as a dictator until his death. He helped found the New England Confederation (see NEW ENGLAND CONFEDERATION). Eaton was born at Stony Stratford, England. BRADFORD SMITH

EAU DE COLOGNE. See PERFUME; COLOGNE (city).

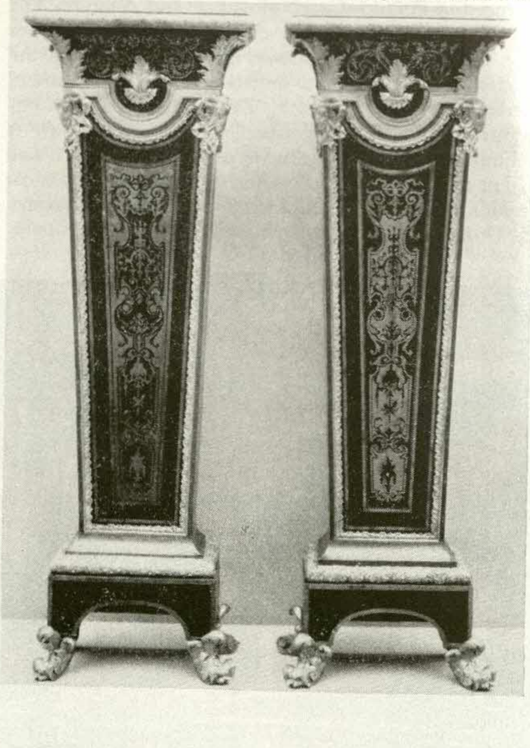
EAVES. See HOUSE (House-Building Terms).

EBBINGHAUS, *EB ing howz*, **HERMANN** (1850-1909), was an early experimental psychologist who performed highly original work in the study of memory and association. He invented the *nonsense syllable*, a short word of little or no meaning, and memorized many lists of them to develop a set of principles to describe the way people learn. In 1897, he wrote *Grundzüge der Psychologie* (Characteristics of Psychology). He taught at Berlin University, at Breslau (now Wrocław), and at the University of Halle. KENNETH E. CLARK

EBONY is a hard, black wood which can be polished to a beautiful metallic luster. The color of this wood is the source of the common expression "black as ebony."

Ebony belongs to the botanical genus *Diospyros.* Various species of this genus grow in Japan, the Philippines, the East Indies, India, Ceylon, Malagasy, Africa, and North and South America.

Only the heartwood of ebony is dark-colored. The *sapwood*, or outer wood, is white or grayish or pinkish-



Ornamental Ebony Pedestals are inlaid with brass and decorated with gold trim. Black ebony wood forms a striking contrast when used as a background for lighter colors.

Metropolitan Museum of Art

The Metropolitan Museum of Art

Ebony Statue was hand-carved in Europe in the 1600's.

white. In some species of ebony the heartwood is dark brown instead of black, and may contain streaks of light brown, red, or yellow. The heartwood fibers of ebony are filled with a hard brownish-black or black gum. This gum is probably responsible for the brittleness of ebony, which makes it well-suited for turning and carving. The black heartwood weighs 70 or more pounds per cubic foot. The light-colored, tough sapwood weighs from 50 to 55 pounds a cubic foot.

The blackest ebony is found in India and Ceylon. The persimmon trees of the United States and the Orient are species of ebony, but these trees have so little black heartwood that it has no commercial value. The wide, hard sapwood of the American persimmon is used to make shuttles and wooden heads for golf clubs. Ebony is used mainly for black piano keys, flutes, the handles of knives and brushes, ornamental cabinets, wood inlays on furniture, and other ornamental objects.

Scientific Classification. Ebony and persimmon trees belong to the ebony family, *Ebenaceae*. The ebony trees of India and Ceylon are classified as genus *Diospyros*, species *ebenum*. ARTHUR KOEHLER

See also PERSIMMON.

EBRO RIVER, *AY broh*, is a stream in northeastern Spain. The Ebro rises in the province of Santander and flows southeast along the borders of the Basque provinces of Old Castile and Navarre to empty into the Mediterranean Sea. It is about 400 miles long. The river has many small branches. Canals have been dug around shoals and rapids of the Ebro so that boats can travel over parts of the river. The Ebro drains plains that are surrounded by highlands. Some of the land is irrigated for raising wheat. These plains are good grazing lands for sheep. Most of the wood produced in Spain comes from the Ebro Valley. R. C. MARTIN

ECCLESIASTES, *eh KLEE zih AS teez*, is a book in the Old Testament, or Hebrew Bible. Its name comes from a Greek word meaning *a gatherer, or speaker, at assemblies*. The author describes himself as "son of David, King in Jerusalem," and tradition says that King Solomon wrote Ecclesiastes. But many scholars believe that the author actually lived at a later time, probably about 250 B.C.

The book is a collection of essays and thoughts on life. Its author questions many accepted beliefs of his time. He never doubts the existence of God, but is troubled by the injustice in the world, and by the fact that the meaning of life is hidden from man. He urges men to find joy in life, because all the usual goals are "vanity of vanities." The book contains many famous and beautiful passages. It ends with a moving poem on the tragedy of old age. ROBERT GORDIS

ECHEGARAY, *AY chay gah RAH ee*, **Y EIZAGUIRRE, JOSÉ** (1832-1916), a leading Spanish dramatist, shared the Nobel prize for literature in 1904. He is known for his complicated plots and the violent passions of his characters. His masterpiece, *El gran Galeoto*, or *The Great Go-Between* (1881), shows how slander can ruin lives. He was born in Madrid. HARVEY L. JOHNSON

ECHIDNA, *ee KID nuh*, is a mammal closely related to the duckbill, or *platypus*. It eats insects, and is also called the *spiny anteater*. The echidna lives in Australia, Tasmania, and New Guinea.

The echidna has a flattened body about 12 to 18 inches long, covered with coarse hair and sharp spines. It has strong claws on its four feet, which it uses to dig its underground nest and scratch up insects from the soil. Its mouth and nose form a long slender beak. The echidna uses its long whiplike tongue to lick up insects. It has no teeth, and swallows its food whole.

The echidna lives in open forests. It stays underground during the day, and comes out to feed at night. The female echidna lays two small white eggs which are covered with a tough skin. The eggs are hatched in a pouch, or fold of the skin of the female's belly. The young echidnas remain in the pouch for several weeks and feed on their mother's milk.

Scientific Classification. The echidna belongs to the family *Tachyglossidae*. It is classified as genus *Tachyglossus*, species *aculeatus*. ROBERT T. HATT

See also ANIMAL (color picture, Australia, New Guinea, and Tasmania); PLATYPUS.

ECHINODERM, *ee KY noh durm*, is the name given to a group of sea animals. Echinoderm means *spiny-skinned*, and most of these animals have a spiny covering. There are about 4,000 different kinds, found in the seas throughout the world. Examples are the starfish, brittle stars, sea urchins, sea cucumbers, and sea lilies.

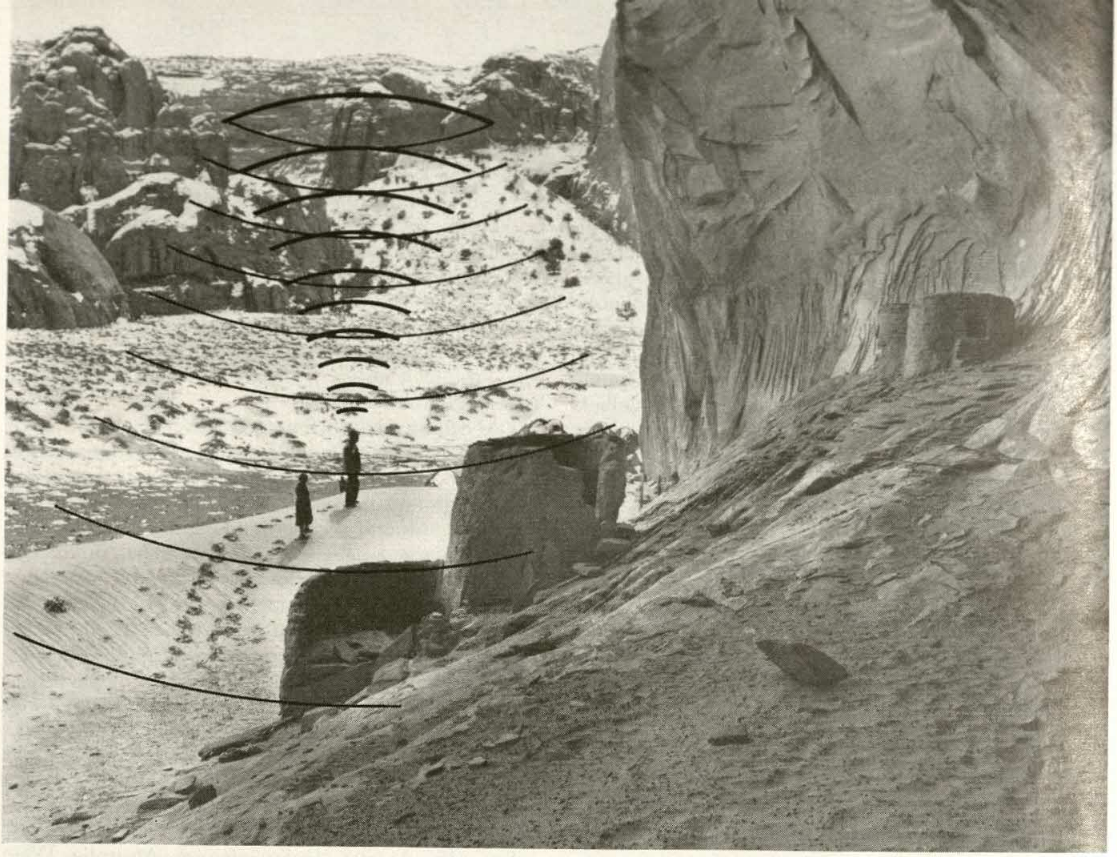
The basic plan of the echinoderm is called *radial symmetry*. This shape consists of an arrangement of organs around the center of the animal like the spokes of a wheel around the hub. The mouth of the echinoderm is on the underside of the body. Around the mouth on the internal side is a canal, shaped like a ring, which branches into long tubes. The tubes radiate from the mouth, again like the spokes of a wheel. The tubes connect with structures called *tube feet* which are used for moving about, for breathing, and for sensing. This tube arrangement is filled with water.

The body wall of almost all echinoderms contains a skeleton which consists of hard plates. These plates interlock with one another, and are made up of calcium carbonate. The plates often bear spines which protect the animal. The echinoderm's digestive and reproductive organs are in the body cavity. The echinoderm reproduces by laying eggs. Most echinoderms feed on clams, oysters, sea snails, and barnacles.

Scientific Classification. The echinoderms make up the phylum *Echinodermata* in the animal kingdom. The five classes are *Asteroidea* (starfish), *Ophiuroidea* (brittle stars), *Echinoidea* (sea urchins), *Holothuroidea* (sea cucumbers), and *Crinoidea* (sea lilies). ROY WALDO MINER

See also SEA CUCUMBER; SEA LILY; SEA URCHIN; STARFISH.

ECHINUS. See ARCHITECTURE (Architectural Terms).



Josef Muench

A Shout Produces 18 Distinct Echoes from the red sandstone formations surrounding Echo Cave in Monument Valley on the border of Arizona and Utah. The valley is part of the Navaho Indian reservation. The ruins nestled in the sand, *foreground*, are the ancient dwellings or storage bins of some prehistoric people, preserved by the dry climate of the Southwest.

ECHO is a sound that we hear after it is *reflected*, or bounced back, from some object. When we shout or clap our hands, sound waves travel through the air in all directions. We first hear the sound when the waves reach our ears (see SOUND [What Is Sound?]). If the sound waves also hit some large object, such as the side of a building, they bounce back and may reach our ears a second time. The second sound is called an *echo*. It is probably named for the nymph Echo in Greek mythology (see NARCISSUS).

Sometimes we do not hear echoes even though the reflected sound waves reach our ears. We may not hear an echo if the original sound is too weak, or if the reflecting object is too small. We may not be able to tell the difference between the original sound and the echo if the object that reflects the echo is less than about 30 feet away.

At other times, we may hear more than one echo from just one original sound. Such repeated echoing usually occurs in valleys and canyons where there are many sound-reflecting surfaces. The sound waves bounce from wall to wall and may produce several distinct echoes.

Echoes are useful because they can help us find out how far we are from echo-producing objects. Sound waves travel about a mile in five seconds. It takes 10 seconds for sound to reach an object a mile away and return. A man who wishes to know how wide a canyon is may stand at the edge and shout. If he hears the echo of the shout five seconds later, he knows that the canyon is about a half mile wide. Sailors may also use echoes in foggy or stormy weather to find out how far they are from cliffs along the shore.

Sound waves traveling through water also produce echoes. A device called *sonar* uses underwater echoes to measure depth and to locate underwater objects. It is used in navigation to locate underwater channels, and can even detect schools of fish. RICHARD H. BOLT

See also BAT (How Bats Fly); RADAR (picture, How Radar Works); SONAR.

ECHO, a nymph. See NARCISSUS.

ECHO, an earth satellite. See SPACE TRAVEL (table).

ECHO RIVER. See MAMMOTH CAVE NATIONAL PARK.

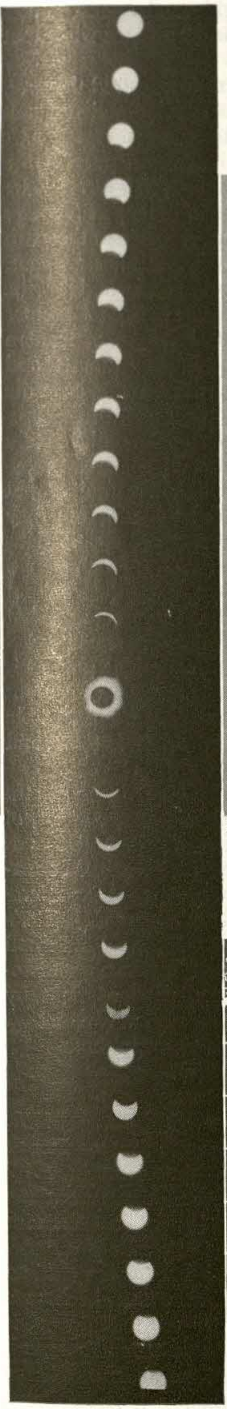
ECK, JOHANN (1486-1543), a German debater and writer, was a powerful opponent of Martin Luther. He was born in Swabia, an area that now lies in southwestern Germany. Eck entered the University of Heidelberg at the age of 11, and was graduated from Tübingen at the age of 14. In 1510, he became professor of theology at Ingolstadt. In 1519, Eck debated with Luther in Leipzig on the question of papal supremacy. Eck defeated Luther in the debate. He charged Luther and Andreas Bodenstein Carlstadt, an extreme reformer, with heresy. At Eck's insistence, the pope in 1520 issued an edict of condemnation against Luther. Eck attended the famous diets at Augsburg and Worms. See also LUTHER, MARTIN.

ECKERSALL, WALTER H. See FOOTBALL (Famous Football Players and Coaches).

ECKHART, JOHANNES, called *Meister Eckhart*, was a Christian mystic. See MYSTICISM.

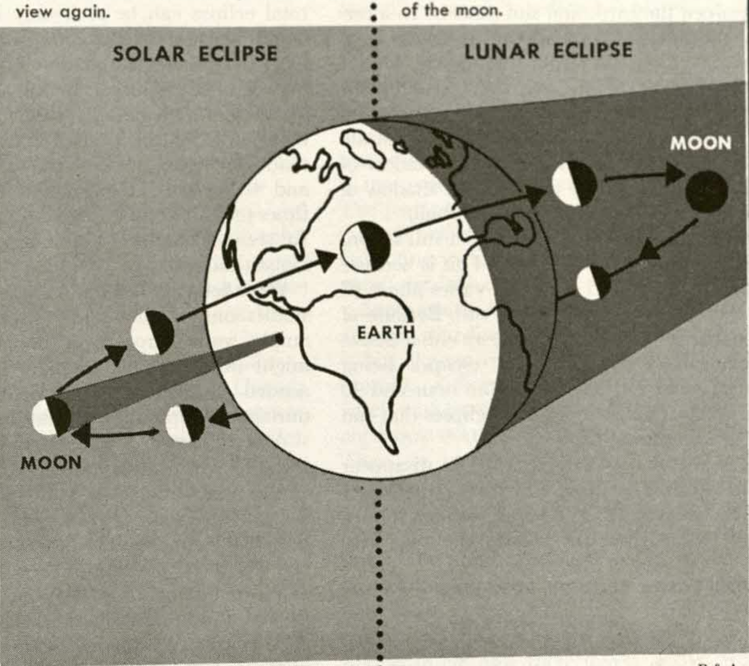
ECLIPSE, *ee KLIHPS.* When one heavenly body is hidden by the shadow of another, it is *eclipsed.* If it is not entirely hidden by the shadow, a *partial* eclipse occurs. If it is completely hidden, it is a *total eclipse.* When the earth passes between the sun and the moon so that the moon is completely in the earth's shadow, the moon cannot be seen. An eclipse of the moon is called a *lunar eclipse.* When the moon passes between the earth and the sun so that we cannot see the sun, the sun is in eclipse. This is called a *solar eclipse.*

What Causes Eclipses. A simple experiment will show what causes eclipses. Cover one eye and hold a marble a short distance in front of the other eye between the eye and the moon. At a certain distance, the marble

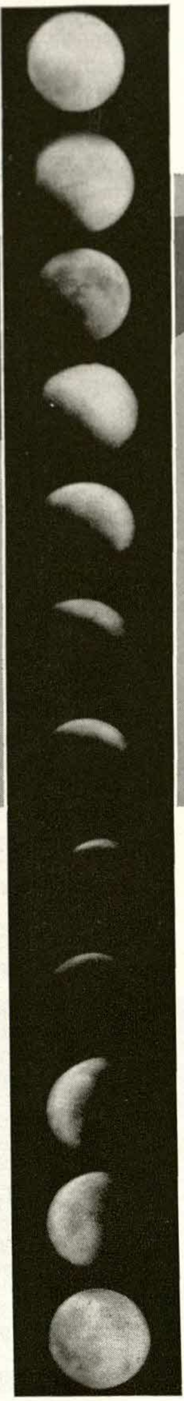


A Solar Eclipse in a series of pictures, *left,* shows how the moon gradually moves across the sun, then covers it completely. The *corona, center left,* flashes into view and the sun slowly moves into view again.

A Lunar Eclipse occurs when the full moon enters into the earth's shadow. At this time, the earth lies directly between the moon and the sun. Photographs, *right,* show a partial eclipse of the moon.



National Geographic Society



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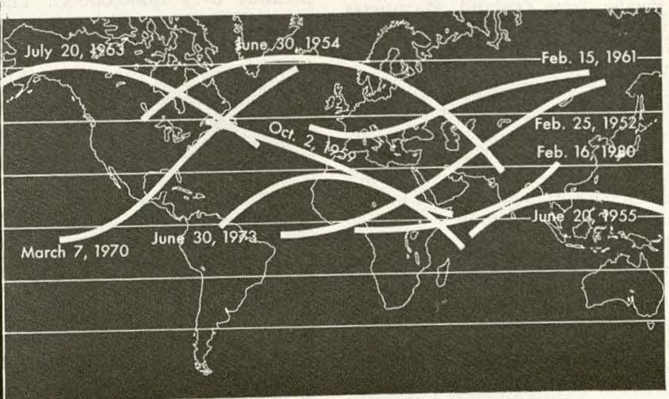


Paths of Solar Eclipses over a 32-Year Period completely hides the moon. When the marble is moved closer to the moon, the outer ring of the moon will be visible around the marble. This is called an *annular eclipse*. A *partial eclipse* can be made by moving the marble a little to one side so that only part of the moon can be seen.

Solar and lunar eclipses can easily be demonstrated in a darkened room with the aid of a flashlight and two balls of a different size, such as a soft ball and a golf ball. The flashlight represents the sun, the large ball represents the earth, and the small ball the moon. Place the large ball, earth, on the table and illuminate it with the flashlight, the sun. Now hold the small ball, the moon, between the earth and sun models. In a certain position, the shadow of the moon just touches the earth. Slowly move the moon from side to side, so that its shadow traces a path on the earth. At a certain point within this path, the moon passes between the earth and the sun, causing a solar eclipse. To demonstrate a lunar eclipse, place the small ball in the shadow of the large ball. A partial eclipse occurs if the shadow of the large ball covers only part of the small ball.

Lunar Eclipses take place only during a full moon, but they do not occur every full moon. This is because the path of the moon around the earth varies about 6° from the path of the earth around the sun. Because of this difference, the moon frequently passes either above or below the earth's shadow, and escapes being eclipsed. A total lunar eclipse may last an hour and 40 minutes. The greatest number of lunar eclipses that can occur in one year is three.

Actually, the moon may not completely disappear from sight during a total eclipse. Sometimes it becomes copper colored, because the sun's light strikes the atmosphere and refracts into the earth's shadow. This light is reddish because particles in the atmosphere scatter the blue light. If the earth's atmosphere has much cloudiness, all light rays may be absorbed and the moon may disappear completely from sight.

TOTAL SOLAR ECLIPSES, 1960-1980

Date	Path of Total Eclipse
Feb. 15, 1961	Bay of Biscay, France, North Italy, southeast Europe, north Asia, Arctic Ocean
Feb. 5, 1962	Borneo, New Guinea, central and north Pacific Ocean
July 20, 1963	Japan, Bering Sea, Alaska, northern Canada, mid-North Atlantic Ocean
May 30, 1965	South Pacific, New Zealand, Marquesas Islands, Peru
May 20, 1966	Atlantic Ocean, Northwest Africa, Mediterranean Sea, Asia
Nov. 12, 1966	Pacific Ocean (west of Galápagos), southern South America, Indian Ocean
Nov. 2, 1967	Antarctic Ocean, Antarctica
Sept. 22, 1968	Arctic Ocean, northern Russia, central Asia
Mar. 7, 1970	Central Pacific Ocean, Mexico, Florida, mid-North Atlantic Ocean
July 10, 1972	Northeast Asia, Alaska, northern Canada, mid-Atlantic Ocean
June 30, 1973	Northern South America, Atlantic, northern Africa, mid-Indian Ocean
June 20, 1974	Southern Indian Ocean, Antarctic Ocean
Oct. 23, 1976	East Africa, Indian Ocean, Australia, near New Zealand
Oct. 12, 1977	Mid-North Pacific Ocean, South America
Feb. 26, 1979	North Pacific Ocean, northwest United States, Canada, central Greenland
Feb. 16, 1980	Atlantic Ocean, central Africa, Indian Ocean, India, southern China

Solar Eclipses. An eclipse of the sun is an awe-inspiring sight. It always begins on the sun's western side and ends on its eastern side. At a total eclipse, the beautiful *corona*, or circle of light, around the sun becomes visible. Men once thought eclipses were miracles. But modern astronomers thoroughly understand eclipses and can predict the times of their occurrence with great precision.

Solar eclipses occur in cycles of time, called the *saros*, which equal 18 years and 11½ days. The ancient Chaldeans discovered the saros. The term means *repetition*. A total eclipse can be seen only in certain parts of the world, because the path of a total eclipse is never wider than 167 miles. The shadow of the moon, as it comes between the earth and the sun, sweeps across the earth at speeds ranging from 1,100 to 5,000 miles an hour, depending on the part of the earth touched by the shadow. The solar eclipse may last as long as 7 minutes and 40 seconds. The longest total eclipse of modern times took place in June, 1955. It lasted 7 minutes and 7.8 seconds. Eclipses visible near the equator have the longest duration.

What Eclipses Tell Us. Astronomers can make certain studies only during solar eclipses. Years ago, for example, some astronomers thought that a small planet might exist between Mercury and the sun, but they needed an eclipse to test their belief. Investigations during an eclipse showed that there was no such planet.

Albert Einstein developed an important theory about the effect of gravitation on light. He predicted that gravitational interaction caused light from stars beyond the sun to *deviate*, or swerve, from a straight path as it passed the sun. A deviation would cause an apparent change in the position of the stars that are observable near the sun at eclipse. Einstein's theory was tested and proved during an eclipse.

At eclipses, astronomers can also observe the spectra of the corona and the *chromosphere*, or outer layers, of the sun. This provides important information about the chemical and physical make-up of these areas. For example, such studies reveal that the corona has a temperature over 1,000,000°C. The eclipses of Jupiter's satellites by Jupiter's shadow can be seen with a small telescope. In 1675, Olaus Roemer, a Danish astronomer, discovered the approximate speed of light by studying Jupiter's eclipses. R. William Shaw

See also Algol; Corona; Digit; Moon; Sun.

ECLIPTIC. See Astronomy (Terms).

ECLOGUES. See Virgil.

ÉCOLE DES BEAUX-ARTS, *AY KAWL day BOH ZAHR*, is a school of fine arts in Paris, sponsored by the French government. Cardinal Mazarin founded it in 1648. Since then, its influence has spread throughout the world. Architecture is the school's most important branch. The school also offers courses in painting, drawing, sculpture, engraving, modeling, and gem cutting. It has the reputation of being conservative, because it resists sudden new ideas in the art world. However, it gives students thorough training in design and composition. Since 1666, the school has granted the famous *Grand Prix de Rome* (Grand Prize of Rome). R. Freeman Butts

ECOLOGY, *ee KAHL oh jih,* is the branch of biological science that deals with the relations between living things and their *environments*, or surroundings. Ecologists study the effect of the environment on the form, habits, and spread of plants and animals. They also deal with the effect of plants and animals on each other and on their environment. Ecologists study climate and the nature of the land and the sea. All these things determine the kind of animals and plants that will live in a particular region.

Ecology is often divided into *plant ecology* and *animal ecology*, but under natural conditions plants and animals live together in one *environment*, or community. Ecology may also be divided into *marine ecology*, the study of life in the ocean, and *terrestrial ecology*, the study of life on land.

Life Zones are areas that generally have the same type of climate and animal and plant life. Environments on land change in a regular way from the poles to the equator and from mountaintops to valleys. Conditions high up on a mountain resemble conditions at sea level farther north. From the north polar regions to the equator, there are seven major life zones.

The Arctic Zone is a region of continuous snow and ice. Few land plants or animals live there. But an enormous number of marine animals and plants (mostly algae) live in the polar seas. More life is found in these seas than in the tropical oceans. Scientists do not know the reason for this.

The Tundra lies south of the arctic zone. It consists of vast treeless plains that extend across northern Canada and Eurasia. Reindeer, muskox, arctic fox, sphagnum, and reindeer moss (a kind of lichen) thrive in the tundra. Alpine flowers bloom in profusion during the brief summers. The timber line marks the southern or lower border of the tundra (see TIMBER LINE).

The Taiga is a broad zone of *conifers*, or evergreens, that runs south or down from the timber line. This zone stretches across Siberia, northern Europe, and Canada. Moose and many kinds of rodents live in the taiga.

The Deciduous Forest of oak, hickory, beech, and maple lies below, or south of, the taiga. Deer are common in the deciduous forests.

The Grasslands, also called *prairies*, *steppes*, *veldts*, and *pampas*, lie south of the deciduous forest zone in many parts of the world. These areas have a heavy growth of grasses and small plants. Many grazing animals roam the grasslands of the world, including antelope, bison, and zebra. Rodents, including hares and gophers, are also common.

The Deserts are dry and hot during a large part of the year. Many of them lie near the grasslands. Most animals that live in the desert are *nocturnal*, or move about mainly at night. Cactus and small trees grow in the deserts in the western parts of the United States.

The Tropical Rain Forests are found in central and northern South America, equatorial Africa, southern Asia, and the East Indies. Heavy rainfall permits the growth of great numbers of plants, including many large trees and thick underbrush. Many animals of the tropical rain forest live mainly in trees.

Within the major life zones are many smaller living places, including swamps, sand dunes, rivers, and pine-on-sand forests. Each of these has its characteristic plants and animals. The *range* of any plant or animal is the general geographic area within which it lives. The particular kind of living place it prefers within its range is called its *habitat*. For example, the range of the green frog includes most of North America. Lakes and ponds are its habitat.

Successions are orderly changes in the kinds of organisms that live in an area. The organisms and their habits change with changes in their surroundings. For example, differences in light intensity, protection from wind, and changes in the soil may change the kinds of organisms that live in an area, and affect their numbers. Then, in turn, as the kinds of plants and animals change, the environment itself changes. For example, a pond or lake may have underwater plants growing near the floor. As these plants die, they sink to the bottom of the pond. The sinking plants, together with living plants, slow down water currents. More sand and mud begin to settle around them. Gradually, the water becomes shallower. Plants which grow with their roots underground and their leaves above water begin to grow in the area. As more plants grow, more materials settle to the bottom, until the water becomes shallow. The shallow water enables sedges, wild iris, and grasses

The Study of Ecology shows how the supply of food and climate determine what animals inhabit a particular region.

Eric Hosking, NAS

A Basic Ecological Requirement of Animals, that of obtaining food, helps maintain balance of nature in the animal world.

NAS

to grow in the area. Later, still more shrubs and, finally, trees, may grow in the filled-up pond. The environment will have changed greatly.

The final stage of a succession, which remains relatively unchanged for thousands of years, is called the *climax*. For example, the succession after a forest fire usually begins with flowers. Then grasses grow, and then birches. Next, the oaks appear, and finally the maples. The maple forest is the climax community. Scientists believe that after the glaciers retreated, about 15,000 years ago, the tundra with its alpine flowers was replaced by the taiga. The deciduous forest, in turn, replaced the taiga. The changing tree population of a forest is largely controlled by the ability or inability of seedling trees to grow in the shade, among the dead leaves on the forest floor.

The supply of food in a particular region ranks as an important factor in determining what plants and animals can live there. Green plants manufacture food for all other organisms, either directly or indirectly. Many animals eat plants, so the amount and kinds of plants in a region determine the kind of animals that will live there. Flesh-eating animals look for regions where their prey is most abundant.

Populations. The study of populations ranks as one of the most important parts of ecology. Knowledge of populations can tell us how many fish or deer or other game we can catch each year without the danger of causing the animals to become rare or extinct. Ecologists also study ways to reduce the population of undesirable animals, such as rats and mosquitoes.

Any population living in a limited environment, such as bacteria in a test tube, fruit flies in a milk bottle, or elephants on a continent, increases more and more rapidly at first. Then crowding begins to limit the amount of food or space available. The increase slows down more and more until a more or less stable number is reached. Killing or otherwise removing animals from a population at this stage will have little, if any, effect on the total size of the population. For example, if hunting does not reduce the population of deer in a forest, starvation during the winter due to crowding will reduce it. But too much hunting or too much fishing when a population is small can have disastrous effects.

Some populations undergo more or less regular cycles of increase and decrease. The best-known case is that of the Canada lynx and the snowshoe hare. First the hares increase in number. Then the lynx, which eat the hares, increase. The increase continues for several years. Then rather suddenly, the hare population drops. This causes famine among the lynxes, so the lynx population falls. Then the number of hares begins to increase, and the cycle begins again. Ecologists once thought that the lynxes caused the declines in the populations by increasing in numbers faster than the hares, and thus producing their own famine. But they discovered that on the island of Anticosti in the Gulf of Saint Lawrence, where there are no lynxes, the population of snowshoe hares goes up and down just as it does where there are lynxes. The hares may produce the cycle by the effects of overcrowding. The population of lynxes depends on the hares' cycles.

Interactions, or the reactions of organisms to one another, is also dealt with in ecology. Plants may shelter animals from their enemies or from bad weather. Animals help spread plants by scattering their seeds. Worms and other burrowing animals may greatly improve the soil for plant growth.

The reactions of certain organisms toward others may be highly developed, or specialized. Certain caterpillars, for example, feed on the leaves of only one kind of plant. They cannot live anywhere that plant does not grow. Animals and plants may live on one another as *parasites*. Tapeworms, liver and lung flukes, the malarial organism, most disease-producing bacteria, and many nematodes, or roundworms, are parasitic. Sometimes two kinds of organisms live in a close relationship which is beneficial to both of them. Such a situation is called *symbiosis*. For example, a kind of *protozoan*, or one-celled animal, lives in the intestines of termites. The protozoan uses some of the termite's food. But, in return, the protozoan digests wood cellulose, which the termite cannot do, so that the termite can use the wood as food. See PARASITE; SYMBIOSIS.

Man also interacts with plant and animal life. He may exterminate animals by hunting, or by destroying their living places or food sources. He may introduce an animal or plant into a new area. In many cases, the new animal or plant increases enormously in numbers and becomes a pest. Man modifies all the biological communities in which he lives. See CONSERVATION.

Through the study of ecology, man can learn to preserve favorable balances of nature. He can control changes in plants and animals that result when land is cultivated or forests cut down. He can counteract the effects of fires, overgrazing, erosion, and floods. Knowledge of the principles of ecology enable man to preserve and use wisely the natural resources. GAIRDNER B. MOMENT

Related Articles in WORLD BOOK include:

Adaptation
Animal
Balance of Nature
Biology
Environment
Geography
Plant

ECONOMIC ADVISERS, COUNCIL OF, is a three-member group which advises the President of the United States on economic problems. The Council has no authority, but operates mainly to keep a constant watch over changes in income, production, and employment. It recommends economic policies to the President and helps him prepare reports to Congress. The Council was set up in the Executive Office of the President in 1946. Its members are appointed by the President and approved by the Senate. JOHN C. BOLLENS

ECONOMIC ASSOCIATION, AMERICAN, is a society organized to serve economists who practice their profession in government service and in academic and business fields, as well as businessmen, lawyers, and journalists who are interested in economic subjects.

The association holds annual meetings and publishes the *Papers and Proceedings* of these meetings. Its official quarterly journal, the *American Economic Review*, was established in 1911. Other publications include occasional monographs, handbooks, directories, and a series of readings. These publications furnish an outstanding guide to contemporary American economic thought.

A small group of specialists, most of them academic economists, organized the association in 1885 at Saratoga, N.Y. They wanted to encourage discussion and research and to issue publications. The association has grown to include more than 9,000 members and 3,600 subscribers, and is the largest of the social science associations. Headquarters are at Northwestern University, Evanston, Ill.

JAMES WASHINGTON BELL

ECONOMIC DEMOCRACY is a general term that has been used to describe the economy of the United States. In an economic democracy, the country maintains a system of free enterprise and competition in business. It seeks maximum production and a fair distribution of goods and services at a minimum cost to human and natural resources. The basic activities of the American economy are agriculture, mining, and manufacturing. Transportation, wholesale and retail trade, communications, finance, and government have stimulated these activities. All such activities, the goods and services they produce, and the organization that guides the production provide the high level of living enjoyed by the people of the United States. See also FREE ENTERPRISE SYSTEM.

JOHN H. FREDERICK

ECONOMIC PROSPERITY. See INFLATION AND DEFLATION; GOVERNMENT (Definition).

ECONOMICS is the study of the way in which groups of people use resources to satisfy their wants. Our wants are many and varied. We all want the food, the clothing, and the shelter which we need to stay alive. But most of us want much more. We want such things as television sets, new cars, and tickets to baseball games. In fact, our capacity to want seems to be almost unlimited. But our incomes usually are much too small to permit us to buy everything we would like to have. *This gap between what people would like to have and what they are able to get is the basic problem studied in economics.*

One way to narrow this gap would be for each of us to *want less,* or be content with little; another way would be for each of us to *produce more.* The economist cannot say which way is better.

Production is the use of resources to create things which satisfy human wants. It includes not only creating things, in the sense of raising wheat, but doing everything else which enables the product, or *good,* to satisfy wants—transporting the wheat to market, grinding the flour, baking the bread, selling the bread. Every act which increases the ability of goods to satisfy wants is a part of production. See PRODUCTION.

The basic *resources* used in production are the human beings who contribute their labor, and the resources provided by nature. Thus we have human resources and natural resources. The earliest men used natural resources by merely gathering the plants or hunting the animals that they knew how to use for food. This was hard work then, but it was more like finding than producing. Later, men learned to till the fields and raise plants on purpose, and to tame the animals. Also, they found that if they spent some time making tools, carts, and so forth, they could produce more of the things they wanted. This meant that they were using capital.

Capital does not refer to money alone. It refers to goods which are not used to satisfy wants directly, but instead are used in producing other goods which do satisfy wants directly. The giant blast furnaces in the steel mills, the tractors and combines on the farms, and the expensive manufacturing plants are part of the great stock of goods used as capital in modern economies.

But with the use of more complex, capital-using methods of production, a need for a special type of labor became evident. Men were needed to collect, organize, and manage the resources used in production. This special type of labor is usually called *management,* or *entrepreneurship.* Economists usually add both capital and management to the list of resources and speak of four types of resources: (1) *land* (meaning all natural resources), (2) *labor,* (3) *capital,* and (4) *management.* The income received by the owners of each type of these four resources is called, in order: (1) *rent,* (2) *wages,* (3) *interest,* and (4) *profit.*

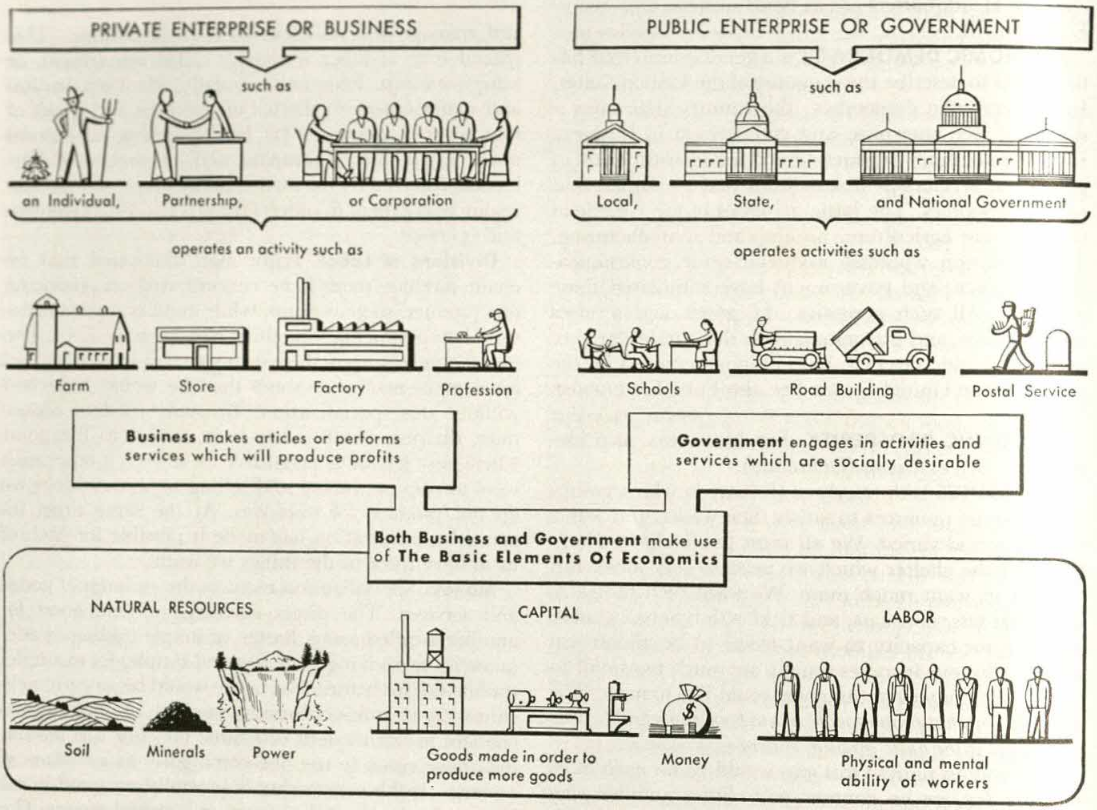
Divisions of Labor. Early man discovered that he could produce more if he concentrated on producing one product, such as grain, while another man concentrated on producing something else, such as shoes. The two then exchanged their surpluses and each man had more grain and more shoes than he would have had without this specialization. In many modern economies, division of labor has been carried to the point where very few of us could live for a week if other men were to stop producing and selling to us the things we do not produce for ourselves. At the same time, increased specialization has made it possible for each of us to have more of the things we want.

Money. Specialization requires the *exchange* of goods and services. The direct exchange of one good for another is called *barter.* Barter, or simple trading, is adequate if the exchanges are few and simple, for example, trading fish for berries. But barter would be an extremely clumsy and time-consuming method of making exchanges in our modern economic life. For this reason, men have come to use one commodity as a *medium of exchange.* If this commodity is generally accepted in exchange for goods and services, it is called *money.* The early Romans used cattle as money, and we get our word *pecuniary,* meaning having something to do with money, from *pecus,* the Latin word for cattle. Money in the United States consists of *coins, currency* (dollar bills, for example), and *check currency* (checks drawn on deposits in banks). See MONEY.

Economic Organization. A Robinson Crusoe alone on an island would be his own economic organization. He would decide what he wanted to produce, and assign himself to the various jobs to be done. His income would be whatever resulted from his own labor. But the problem of organizing an entire modern economy is much more complex. The critical decisions which have to be made are: (1) what things are to be produced to satisfy people's needs or wants, and in what amounts? (2) what job is each worker, each manager, each unit of capital, and each piece of land going to perform? and (3) what share of the things produced is to go to each person? If the people wish to reach ever higher standards of living, then the economic organization must also handle a fourth decision: What provisions are to be made for getting more and better resources, and for improving the techniques of production? The economic organization of a society is the system that men use to make these decisions.

Free Enterprise. In the United States and in some other countries, these economic decisions are handled through a system called free enterprise. How is this system supposed to work? What problems arise under it? How can these problems be solved? Average citizens, as well as economists, should study these questions.

HOW OUR ECONOMIC SYSTEM IS ORGANIZED


PRIVATE ENTERPRISE OR BUSINESS
such as
an Individual,
Partnership,
or Corporation
operates an activity such as
Farm
Store
Factory
Profession
Business makes articles or performs services which will produce profits
PUBLIC ENTERPRISE OR GOVERNMENT
such as
Local,
State,
and National Government
operates activities such as
Schools
Road Building
Postal Service
Government engages in activities and services which are socially desirable
Both Business and Government make use of **The Basic Elements Of Economics**
NATURAL RESOURCES
Soil
Minerals
Power
CAPITAL
Goods made in order to produce more goods
Money
LABOR
Physical and mental ability of workers

In general, free enterprise is supposed to work in this way. The consumer is "boss." He decides what he wants produced and everyone jumps to satisfy him. The thing that makes people jump is self-interest, particularly the desire to make money. The "signals" that people are guided by in a free enterprise system are prices, wages, interest rates, rents, profits, and losses. These signals tell management such things as whether to make more or less of a product, tell workers which jobs to take, and tell investors where to invest their money. The "police force" is competition. Competition forces each employer, each worker, each seller, and each buyer to offer the most for the least. If competition exists, no one person can take advantage of another. See FREE ENTERPRISE SYSTEM.

Distribution. In a free enterprise society, goods that are produced are divided on the following basis: *The more you produce, the more you get.* This leads each person to try to produce more, and all consumers benefit if the system is working properly. See DISTRIBUTION.

Free Enterprise and Economic Progress. The desire for more income also leads producers to try to find more resources, to improve their resources, and to find new and better ways of using them. This also helps consumers. What would be our level of living in America today if farmers were still using the same methods, the same tools and machinery, that farmers used 150 years ago? Or if the great inventions of the past one hundred years had not been made? Any person over thirty years of age has seen enough in his own lifetime to testify that *the free enterprise system has been amazingly successful in promoting economic progress.* This is one of the most important advantages claimed for the system.

The Role of Saving. Saving is the act of not spending all one's income for direct consumption. When people save, they are saying to resources that otherwise would have been put to work making bread or some other consumer product for daily living, "You are free to make the tools and machines which will eventually bring us even more bread." For this reason, *economic progress seems to require a high level of saving,* whatever type of economic organization is used. Some economists claim, however, that there can be too much saving, and that this will lead to widespread unemployment. See DEPRESSION.

The Role of Competition. The free enterprise system will not work efficiently if its "police force," competition, is not on the job. The exact meaning of competition is one of the most important topics in economics. In general, economists agree that competition exists when the following conditions are realized: (1) sellers and buyers face more than just one or two choices, or *alternatives;* (2) sellers and buyers have the *information* on which to make the best choices; and (3) each seller and each buyer is willing, able, and free to "move" to the best alternative. This latter requirement is often referred to as the requirement of *mobility.* For example, employers will have to pay each worker what he is worth if each worker can get a job with any one of a number of firms, if he knows the wages paid and the quality of the job at each firm, and if he is willing, able, and free to move from one job to another. How to maintain competitive conditions is one of the most important problems of a country using the free enterprise system.

The Role of Government in Free Enterprise. Free enterprise does not mean a complete "hands off" policy by the government. The government has an important part to play in an enterprise economy. To begin with, the government must set the "rules of the game" under which the players are allowed to compete. Thus our government does not permit individuals to get income by such devices as fraud, robbery, and murder. In the same way, the government must see that the game of free enterprise is played under competitive conditions. The United States government has passed numerous laws to curb the growth of monopolies, with varying degrees of success.

There are some activities which the government must either (1) undertake directly or (2) regulate, if they are left in private hands. Included here would be activities which do not lend themselves to competition. The various public utilities, such as gas, water, and light distribution, and the transit systems, are of this type. Would it be efficient for thirty or more street-railway systems to compete for business in your town? Such activities are often called *natural monopolies,* because only one such system can operate efficiently in its area under these conditions.

The benefits from other activities, such as public education for children, go to all the people in the society. A private firm, selling education, would find it difficult to collect money from all the people who benefit from living in an educated society. A case for public ownership and operation can usually be made in such situations.

We have not listed all the situations which may call for government to take a hand in economic life, but have illustrated some of the principles involved. To draw an exact line between what should be undertaken by government and what should be left in private hands is difficult. This is one of the most hotly disputed questions in economics.

The Problems of Free Enterprise. The problem of maintaining competition is described above. Another important problem confronting free enterprise is the *business cycle.* The business cycle refers to the waves of good and bad times, of prosperity and depression, which have plagued modern economies. Another problem is *labor-management relations.* This is partly an economic problem, and partly a problem in human relations (see LABOR-MANAGEMENT RELATIONS). Other problems are related to *low-income groups;* others to the desire of people for *economic security;* others to our *international economic relations.* The study of these and other problems, and of possible solutions, is an important part of economics.

Other Economic Systems. The distinguishing characteristic of most economic systems other than free enterprise is that all or most of the critical decisions are made by a *central planning and decision-making* group. Under a *fascist* type of economic organization, all these decisions are made with a view to making the nation stronger than its rivals. Also, the members of the planning group are not selected by the citizens, and *force* is often used to carry out the decisions of fascist planners. Germany under Hitler and Italy under Mussolini were modern examples of fascist organization. Many people believe that Russia, though it calls itself communist, really belongs in this group because the dictator rather than the people makes all important decisions. See FASCISM; GOVERNMENT (Comparison).

Under a *socialist* type of economic organization, the goal is usually stated as the same as that of free enterprise: to provide a better living for the people in the society. However, the methods used to achieve this goal under socialism include not only central planning and decision making but also considerable government ownership and operation of the means of production, and emphasis on a more nearly equal distribution of income. If the members of the planning group are elected by the citizens, the system is called *democratic socialism.* The Labour party in Great Britain sponsors this type of socialism. Under socialism, the incentive of self-interest must be largely replaced by the desire to serve society as a whole. Many economists and others feel that the average person will still follow self-interest and that, in the long run, a socialist system will have to rely on force to get people to do what is asked of them. These economists favor a free enterprise system because they feel that it is the only system which can give us both economic efficiency and political and personal freedom. See COMMUNISM; SOCIALISM.

The question of which type of economic organization is best for a certain country cannot be answered on economic grounds alone. Social, religious, historical, and political considerations must be taken into account. In the same way, public policy decisions in a free enterprise economy cannot be made on purely economic grounds. For example, the social value of trade unionism must be taken into account in a full appraisal of the proper role of the union in a modern economy. An understanding of economics is one but not the only requirement for good citizenship in a democracy.

BENJAMIN A. ROGGE. Critically reviewed by JAMES WASHINGTON BELL

Related Articles. See the ECONOMICS and the INDUSTRY AND TRADE sections of the READING AND STUDY GUIDE. See also the lists of Businessmen and Businesswomen and Economists in the BIOGRAPHY section of the GUIDE. See also the following articles in WORLD BOOK:

Banks and Banking
Business
Capital
Capitalism
Conservation
Consumer Education
Consumption
Depression
Distribution
Free Enterprise System
Industry
Labor
Mass Production
Mercantilism
National Debt
National Income
Production
Public Utility
Social Security
Syndicalism
Taxation
Trade
Wealth

ECTODERM. See EMBRYO.

ECTOPLASM, *EHK toh plaz'm,* is a term used in spiritualism or psychic research. It refers to the ghostlike, frothy, vaporous mass, sometimes said to appear at a *séance,* or meeting of spiritualists. If the shape seems to be that of a dead friend of anyone present, it is called *materialization.* Most scientists consider ectoplasm, mediums, and séances to be frauds or clever deceptions. *Ectoplasm* comes from the Greek words meaning *life-stuff formed from without.* In biology, the word means the outermost layer of protoplasm in a body cell. See also SPIRITUALISTS. WILSON D. WALLIS

ECTROPION. See BLINDNESS (Diseases).

ECUADOR

Ecuador faces the Pacific on the coast of South America.

The Republic of Ecuador is a little larger than Colorado.

ECUADOR, *ECK wah dawr,* lies on the western coast of South America between Colombia and Peru. The equator crosses the country. For this reason the country was given the name *Ecuador*, the Spanish word for *equator*. The official name of the country in Spanish is REPÚBLICA DEL ECUADOR, which means REPUBLIC OF ECUADOR. Quito is the country's capital.

Ecuador covers an area slightly larger than Colorado. About the same number of people live in Ecuador as live in the city of Chicago. Over half the people in Ecuador live in the valleys of the Andes Mountains.

Ecuador is a land of brilliant colors. Green, tangled forests cover much of the country. Many mountains are white with snow. Purple and scarlet flowers dot the coastal lowlands. The costumes of the Indians copy the bright colors of the country.

FACTS IN BRIEF

Type of Government: Republic.

Capital: Quito.

Divisions: 18 provinces, divided into cantons and parishes; and 1 national territory (Galápagos Islands).

President: Elected to a 4-year term by the people.

Congress: Senate, 44 members (four-year terms); Chamber of Deputies, 56 members (two-year terms).

Area: 106,000 square miles. *Greatest distance:* (north-south) 450 miles; (east-west) 395 miles. *Coast line*, 500 miles.

Elevation: *Highest*, Chimborazo Volcano, 20,577 feet. *Lowest*, sea level.

Population: 3,613,170. *Density*, about 34 persons to the square mile. *Distribution*, rural, 70 per cent; urban, 30 per cent.

Chief Products: *Agriculture*, bananas, barley, cacao, cattle, coffee, corn, rice, sugar cane, vegetables, wheat. *Forest Industry*, balsa wood, kapok, rubber, tagua (ivory palm tree) nuts. *Mining*, gold, petroleum. *Manufacturing and Processing*, chemicals, cotton goods, drugs, flour, hats, liquors, nails, rugs, soap.

Flag: The coat of arms is centered on horizontal stripes of yellow, blue, and red (top to bottom). The yellow stripe is twice as wide as the other two. See FLAG (color picture, Flags of the Americas).

National Holiday: Independence Day, August 10.

National Anthem: "Himno Nacional del Ecuador" ("Ecuadorian National Anthem").

Money: *Basic unit*, Sucre. For its value in dollars, see MONEY (table, Values).

Ewing Galloway

Bananas by the Bunch are loaded on ships to be carried to other countries. Ecuador leads the world in exporting bananas.

The Galápagos Islands, which lie 600 miles off the Pacific coast, belong to Ecuador. Many scientists have studied the unique wildlife on these islands. See EVOLUTION; GALÁPAGOS ISLANDS.

The Land and Its Resources

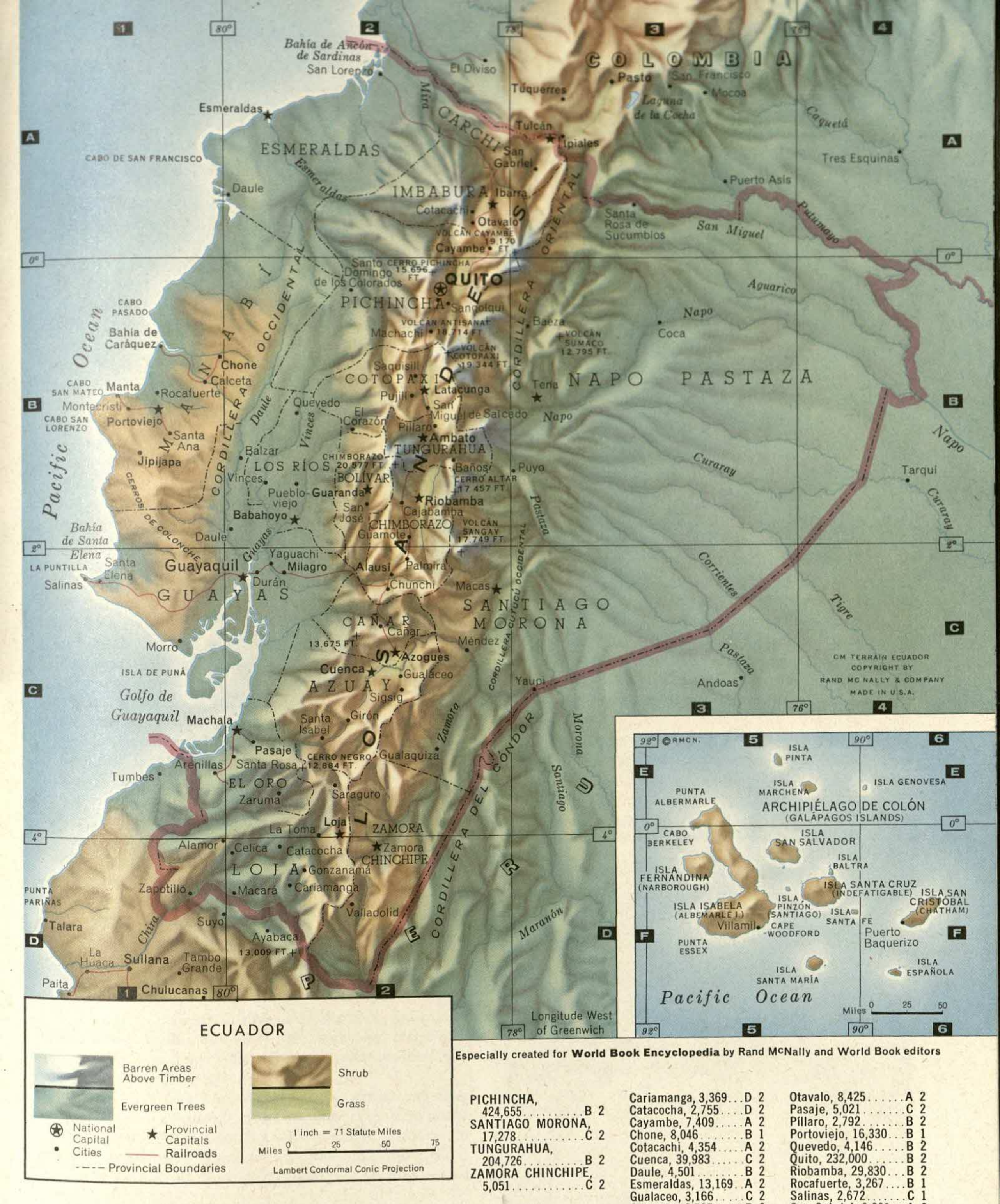
Location, Size, and Surface Features. Ecuador fronts the Pacific Ocean along the west. The *Color Map* shows that Colombia lies north of Ecuador, and Peru is to the east and south. Ecuador covers 106,000 square miles.

Ecuador has three major geographic regions. They are: (1) the *coastal lowlands*, (2) the *Andes highlands*, (3) the *eastern lowlands*.

The *Coastal Lowlands* stretch along the country's 500-mile coast line. The region seldom is more than 100 miles wide. It has many swamps and low hills. The Guayas, Esmeraldas, and Mira rivers cross this region and flow into the Pacific. The Guayas is the most important. It flows south from the Andes and empties into the Gulf of Guayaquil.

The Andes Highlands, often called the *Sierra*, lie in the center of Ecuador. Two parallel ranges of the Andes Mountains, the Eastern and Western Cordilleras, run through the region in a north-south direction. More than 20 volcanoes tower among the ranges. The highest is 20,577-foot Chimborazo. Cotopaxi Volcano is 19,344 feet high and is the tallest active volcano in the world. The two cordilleras are 25 to 40 miles apart. They are joined by eight mountain ridges.

The Eastern Lowlands, also called the *Oriente*, are



Especially created for **World Book Encyclopedia** by Rand McNally and World Book editors

ECUADOR

Provinces

AZUAY, 277,772	C 2
BOLÍVAR, 123,205	B 2
CAÑAR, 107,701	C 2
CARCHI, 84,738	A 2
CHIMBORAZO, 241,258	B 2
COTOPAXI, 179,965	B 2
EL ORO, 103,950	C 2
ESMERALDAS, 87,870	A 2
GALÁPAGOS (Is.), 1,546	E 5
GUAYAS, 663,516	C 1
IMBABURA, 157,356	A 2
LOJA, 252,737	D 2
LOS RÍOS, 174,335	B 2
MANABÍ, 477,503	B 1
NAPO PASTAZA, 28,008	B 3
PICHINCHA, 424,655	B 2
SANTIAGO MORONA, 17,278	C 2
TUNGURAHUA, 204,726	B 2
ZAMORA CHINCHIPE, 5,051	C 2

Cities

Alausí, 5,047	C 2
Ambato, 31,312	B 2
Azogues, 6,588	C 2
Babahoyo, 9,181	B 2
Bahía de Caráquez, 9,316	B 1
Balzar, 2,920	B 2
Baños, 2,691	B 2
Calceta, 3,751	B 1
Cañar, 4,415	C 2
Cariamanga, 3,369	D 2
Catacocha, 2,755	D 2
Cayambe, 7,409	A 2
Chone, 8,046	B 1
Cotacachi, 4,354	A 2
Cuenca, 39,983	C 2
Daule, 4,501	B 2
Esmeraldas, 13,169	A 2
Gualaceo, 3,166	C 2
Guamote, 2,567	B 2
Guaranda, 7,299	B 2
Guayaquil, 290,000	C 2
Ibarra, 14,031	A 2
Jipijapa, 7,759	B 1
Latacunga, 10,389	B 2
Loja, 15,399	C 2
Macará, 3,330	D 2
Machachi, 2,584	B 2
Machala, 7,549	C 2
Manta, 19,028	B 1
Milagro, 16,081	C 2
Otavalo, 8,425	A 2
Pasaje, 5,021	C 2
Píllaro, 2,792	B 2
Portoviejo, 16,330	B 1
Quevedo, 4,146	B 2
Quito, 232,000	B 2
Riobamba, 29,830	B 2
Rocafuerte, 3,267	B 1
Salinas, 2,672	C 1
San Gabriel, 6,269	A 3
San Miguel de Salcedo, 2,596	B 2
Sangolquí, 3,082	B 2
Santa Ana, 4,018	B 1
Santa Elena, 2,775	C 1
Santa Rosa, 4,776	C 2
Saquisilí, 3,217	B 2
Tulcán, 10,623	A 3
Vinces, 3,748	B 2
Yaguachi, 3,176	C 2
Zaruma, 3,922	C 2

Source: Latest available official figures.

made up of slopes and foothills of the Andes, and plains of the Amazon River basin. Many rivers flow through the region and empty into the Amazon. The largest include the Pastaza, Napo, and Putumayo.

Natural Resources. Ecuador has deposits of gold, petroleum, silver, copper, sulfur, and lead. Petroleum and gold are the only minerals that have been developed to any extent. The soil generally is good for farming. Forests cover about three fourths of the country and contain more than 600 kinds of trees. The country is especially rich in balsa, and in cinchona trees, from the bark of which the drug, *quinine*, is made.

Climate. Ecuador lies in the tropics. But the country's different altitudes give it a wide variety of climates. The coastal region is hot and humid, even though the cold Peru (Humboldt) Current flows near the shore (see PERU CURRENT). Temperatures near the coast average about 83°F.

Average temperatures in the highlands range from 45° to 70°F., depending on the altitude. Quito, for example, is almost on the equator, but its climate is cold because it lies more than 9,000 feet above sea level and is surrounded by mountains. About 40-60 inches of rain fall annually in most of Ecuador.

The People and Their Work

The People. More than half the people of Ecuador are Indians. Many of them are descended directly from the Incas who once controlled the region. Most of the Indians live in the highlands. They speak the *Quechuan* language of the Incas, and follow the customs of their ancestors. The Otavalo Indians are the most highly developed modern tribe. The wild *Jivaro* Indians live east of the Andes. They shrink and preserve the heads of enemies they have killed.

Almost one out of every three Ecuadorians is a *Mestizo* (mixed white and Indian). The mestizos live in the coastal and highland areas. About one out of every ten persons is white. These people are mostly descendants of the old Spanish families, and live chiefly in the Andes valleys. A few Negroes live in the coastal region.

Way of Life. About six out of every ten persons live in the high, cool valleys of the Andes. The rest of the people live in the coastal lowlands. Very few people live in the hot, wet land east of the Andes. The people in one section of the country have little to do with those in any other section.

Housing. The standard of living for most persons is low. Many Indian homes in the Andes are stone and mud huts, painted in gay colors. City homes resemble those in other Latin-American cities.

Dress. City dwellers wear clothing similar to that worn in North America. Indians wear brightly-colored *ponchos*, which are blankets with a slit in the middle for the head to go through. Traditional clothing often is worn at festivals. See CLOTHING (color picture, Latin America).

Food. The Indians of Ecuador do not have much variety in their food. Many of the local dishes are made largely of corn. Tamales, and *locro*, a thick soup made of corn or potatoes, are favorites.

Recreation. On certain market days each week, thousands of Indians buy, sell, barter, and trade from sunrise to sunset. The most famous market days are the Saturday Fair at Otavalo, and the Monday Fair at Ambato. Almost every town has a pit for cockfighting, a popular sport throughout Ecuador (see COCKFIGHTING).

Hamilton Wright

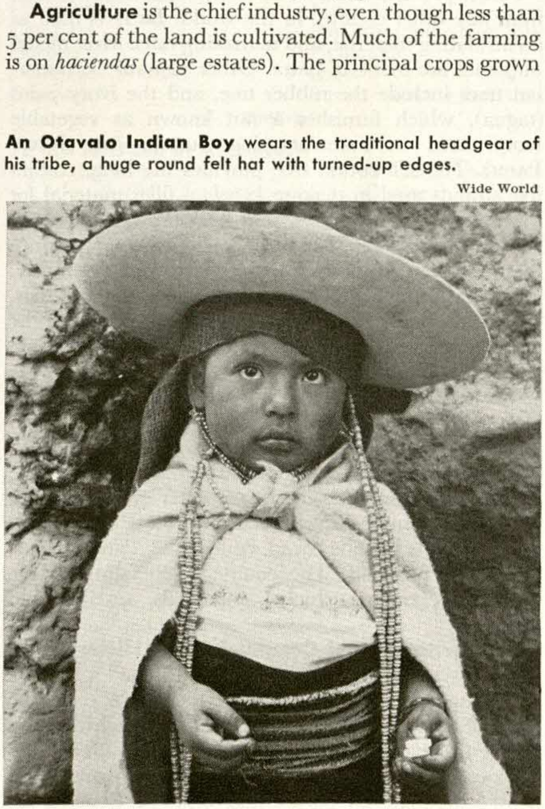
Market Day in Ecuador provides time for exchange of goods and gossip. Dances frequently add gaiety to the day.

Cities. Quito is the capital of Ecuador. Cuenca is a commercial center and a leading exporter of Panama hats. Guayaquil is the country's largest city and chief seaport. See CUENCA; GUAYAQUIL; QUITO.

Agriculture is the chief industry, even though less than 5 per cent of the land is cultivated. Much of the farming is on *haciendas* (large estates). The principal crops grown

An Otavalo Indian Boy wears the traditional headgear of his tribe, a huge round felt hat with turned-up edges.

Wide World



Panama Hats Bleach in the Sun. These hats are made in Ecuador, but are called *Panama* hats because men found them for sale in Panama as they went through on their way to California in the 1849 gold rush.

Lavarre, Gendreau; Hamilton Wright

Flocks of Sheep and Llamas graze in the Andes highlands, often at altitudes of 12,000 feet or more.

for export in the coastal lowlands include bananas, cacao, coffee, rice, and sugar cane. Crops grown for local use are raised along the coast and in the Andes highlands. These crops include wheat, vegetables, corn, and barley. Cattle, sheep, llamas, and goats graze in the highlands, and provide meat and dairy products.

Forestry. More balsa wood comes from Ecuador than from any other country in the world. Balsa is used as an insulating material, and in making rafts. Most model airplanes are made of balsa. Other valuable Ecuadorian trees include the rubber tree, and the ivory palm (tagua), which furnishes a nut known as vegetable ivory, used in manufacturing buttons (see IVORY PALM). The silk cotton tree provides the long, cotton-like strands used in making *kapok*, a filler material for mattresses, life preservers, and cushions (see KAPOK).

Manufacturing. Ecuador's few factories produce many of the manufactured goods used in the country. The chief products include cotton goods, shoes, drugs, chemicals, flour, soap, nails, and liquors. Much of the manufacturing such as rug-weaving and hat-making, is done by hand.

Trade. Ecuador trades mostly with the United States, Germany, France, Great Britain, Argentina, Peru, and Uruguay. In the 1950's Ecuador became the world's leading banana-exporting country. Ecuador is the Western Hemisphere's largest exporter of pyrethrums, flowers used in making insecticides (see PYRETHRUM). Other exports include cacao, coffee, rice, Panama hats, and forest products. The country's chief imports are machinery, motor vehicles, chemicals, textiles, and paper.

Transportation and Communication. Highway and railroad systems have grown slowly in Ecuador because of the rugged Andes Mountains. There are about 1,500 miles of good roads. The Pan American Highway runs through the country from north to south, and highways connect Quito with Guayaquil and Esmeraldas. Most other roads are narrow and unpaved. Ecuador has less than 800 miles of railroads. A rail line connecting Quito with San Lorenzo on the Pacific Ocean was completed in 1956. There is some river travel and much coastal shipping. Airlines provide daily service between the chief cities, and connect Ecuador with other countries in South America and overseas.

Telephone and telegraph lines link the cities of Ecuador. The country also has several radio stations.

Social and Cultural Achievements

Education is free, and the law states that all children between the ages of 6 and 12 must attend school. But many do not go to school. About half of Ecuador's people cannot read and write. The Government controls the educational system. Quito, Guayaquil, Cuenca, and Loja have universities. Loja also has a law school.

Religion. Ecuador has had religious freedom since 1897. Most of the people are Roman Catholics. During most of the 1800's, only Roman Catholics were permitted to worship in public churches.

The Arts. The Indians of Ecuador inherited the art of weaving from their Inca ancestors. Hat weaving is done in the homes, principally near Cuenca and Manta.

Ecuador has produced several fine writers and artists, but most of them are little known outside the country. Probably the best-known author is the essayist, Juan Montalvo (1832-1889).

Government

National Government. The president is elected by popular vote for a four-year term. He cannot be re-elected for at least four years after his term expires. A cabinet helps him with administrative work.

The congress consists of two houses. Two senators from each province and one from the Galápagos Islands are elected by popular vote for four-year terms. In addition, eleven "functional" senators are elected by various economic or cultural groups. They represent such fields as education, agriculture, commerce, industry, labor, and the armed forces. Members of the Chamber of Deputies are elected on the basis of one deputy for every 50,000 persons in each province.

All citizens who are at least 18 years old and can read and write may vote in national elections. Leading political parties are the Conservative, Liberal, and Socialist.

Local Government. Each province has a governor appointed by the president for an indefinite term of office. The Ministry of National Defense administers the Galápagos Islands. Local officials appointed by the national president govern the cantons and parishes of Ecuador.

History

Early Days. The Indian kingdom of Quito, in what is now Ecuador, was already over 2,000 years old when the Incas conquered it in about 1470. Spanish soldiers under the leadership of Francisco Pizarro overthrew the Inca Empire in 1533. Ecuador became an important Spanish possession in South America.

Ecuador prospered under Spanish rule. The Indians were converted to Christianity. They learned to raise cattle, pigs, and wheat. Francisco Xavier de Santa Cruz y Espejo (1747-1795), a doctor, established many improved methods of health and social service.

Independence. A desire for independence swept the Spanish colonies in Latin America in the 1800's. A Venezuelan general, Antonio José de Sucre, liberated Ecuador in 1822. Ecuador joined the countries known today as Colombia and Venezuela, and in 1822 became a part of Greater Colombia, a republic created under the leadership of Simón Bolívar. Ecuador broke away from Greater Colombia in 1830 and became a separate republic. General Juan José Flores became the first president of the new republic. See BOLÍVAR, SIMÓN.

Ecuador probably made its greatest progress in the 1860's and 1870's during the administrations of President Gabriel García Moreno. He encouraged commerce, agriculture, and scientific research. García Moreno also established a currency system and raised the standards of public administration.

The 1900's. Ecuador has had many armed rebellions during the 1900's. Because the government has often been weak, it has not always been able to control remote areas. Strong neighboring nations have taken advantage of this situation and have seized land from Ecuador. Brazil forced Ecuador to give up land in 1904, Colombia in 1916, and Peru in 1942.

Ecuador broke relations with Germany, Italy, and Japan in 1942 during World War II. From 1942 to 1946, Ecuador granted free bases to the United States armed forces on the Galápagos Islands. These bases helped guard the Panama Canal.

Ecuador became a charter member of the United Nations in 1945. A disastrous earthquake struck Ecuador in 1949, bringing death and injury to thousands. The government started a $40,000,000 road-building program in 1954. Camilo Ponce Enríquez was elected president in 1956, the first Conservative to serve in 60 years. In 1960, José María Velasco Ibarra became president for the fourth time. C. LANGDON WHITE

An Indian Woman sits near the stone which marks the line of the equator in Ecuador. The word *ecuador* means *equator* in English.

Hollyman, Photo Researchers

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Chocolate
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Guayaquil
Head-Hunter
Inca
Jivaro Indians
Kapok
Latin America
Pan American Highway
Pichincha
Quito
Sucre, Antonio José de

Outline

I. The Land and Its Resources
  A. Location, Size, and Surface Features
  B. Natural Resources
  C. Climate
II. The People and Their Work
  A. The People
  B. Way of Life
  C. Cities
  D. Agriculture
  E. Forestry
  F. Manufacturing
  G. Trade
  H. Transportation and Communication
III. Social and Cultural Achievements
  A. Education
  B. Religion
  C. The Arts
IV. Government
V. History

Questions

What does the word *Ecuador* mean in English?

What South American countries border Ecuador?

Why does Quito have a cool climate even though it lies near the equator?

What drug is made from the bark of the cinchona tree?

Where do the majority of the people in Ecuador live?

What are ponchos?

What are the chief exports of Ecuador?

How is Ecuador governed?

How did Ecuador become a separate republic?

In what ways did President García Moreno raise the standard of living in the country?

How did Ecuador help the Allies during World War II?

ECUMENICAL MOVEMENT. See CHRISTIANITY (Christianity Today); EVANGELICAL ALLIANCE; WORLD COUNCIL OF CHURCHES.

ECZEMA, *ECK zee muh,* is a chronic inflammation of the skin. The skin becomes red, and fluid-filled pimples, called *vesicles,* may form, or crusts and scales may develop on the skin surface. Usually the area itches. If the person scratches his skin, he destroys the pimples or removes the crusts and scales. For this reason, the appearance of the area changes from time to time.

Doctors believe that eczema is a form of allergy. They think it results from extreme sensitivity to some substance. The substance may be in something the person eats, or it may be found in his surroundings. Most often, persons are found to be sensitive to drugs, chemicals, and foods. Certain substances given off by plants also cause eczema. For example, oils produced by poison ivy and poison oak cause a form of eczema when they come in contact with a person's skin (see Poison Ivy). A person may not develop eczema unless he has been repeatedly exposed to a substance. But once he develops the allergy, cure is difficult so long as he continues to be exposed.

Doctors test the sensitivity of persons to various substances to find the cause of the condition. Treatment of eczema usually involves removing the cause of the condition.

W. B. Youmans

See also Allergy; Dermatitis.

EDDA, *ED uh,* is a title applied to two ancient works in Scandinavian literature. The *Elder,* or *Poetical, Edda* consists of 34 songs about the Scandinavian gods and heroes. It was compiled at intervals during the 1100's and the 1200's. The *Younger,* or *Prose, Edda* concerns itself with Northern mythology and the composition methods of the *skalds,* or ancient poets. The Prose Edda was written by Snorri Sturluson, a historian and politician of Iceland in the first half of the 1200's. The work was intended as a guide to young poets, and was first published in the 1600's. Richard Wagner borrowed materials from the Eddas for his four operas, *The Ring of the Nibelungs.*

Richard Beck

See also Skald; Snorri Sturluson.

EDDINGTON, SIR ARTHUR STANLEY (1882-1944), a British astronomer, early became interested in the structure of the universe and in the motions and internal constitution of the stars. In 1916, he concluded that radiation pressure is a major factor, along with gravitation and gas pressure, in maintaining a star's equilibrium. He then showed the relationship between the mass and the brightness of a star. This relationship is fundamental to astronomical research, particularly the study of the evolution of stars. This and other work on the nature, composition, and structure of stars led him to search for a relationship between all the fundamental constants of nature.

Eddington was born at Kendal, England. He showed brilliance as a child, and studied at Manchester and Cambridge universities. During the eclipse of the sun in 1919, he was the first to observe the deflection of light by the sun's gravitational field. Einstein had predicted this in his general theory of relativity.

Eddington wrote several books that explained the nature of the universe in popular terms. His books include *Stellar Movements and the Structure of the Universe* (1914), *Internal Constitution of the Stars* (1926), and *The Nature of the Physical World* (1928).

Helen Wright

EDDY, MARY BAKER (1821-1910), was the founder of Christian Science and the Church of Christ, Scientist. She was born and grew up on a farm near Concord, N.H. She was married in 1843, but her husband died less than a year later. Poor health, separation from her only child, and other misfortunes caused her to turn more and more to the Bible for relief and guidance. In February, 1866, she suffered a severe injury. She was healed while reading about one of Jesus' healings in Matthew 9: 1-8.

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Mary Baker Eddy

She then spent the next few years searching the Bible for laws underlying spiritual healing. In 1875, she published her chief work, *Science and Health with Key to the Scriptures.* She was married to Asa G. Eddy in 1877, and he helped her with the work of establishing Christian Science. In 1879, Mrs. Eddy organized the Church of Christ, Scientist, and directed it until she died. In 1908, she founded the daily newspaper, *The Christian Science Monitor.*

Will B. Davis

See also Christian Scientists; New Hampshire (Interesting Places to Visit).

EDDY, NELSON (1901-), an American baritone, became best known as a concert singer and a performer on radio and in motion pictures. Born in Providence, R.I., he began his career as a boy soprano. After his voice changed, he sang with a Gilbert and Sullivan opera troupe and the Philadelphia Civic Opera Company. Eddy financed his early music studies by working as a newspaper reporter.

Martial Singher

EDDY, WILLIAM A. See Kite (How Kites are Used).

EDELINCK, *AY duh link,* **GÉRARD** (1640-1707), was a Flemish engraver. He helped develop French portrait engraving to its highest point. Born in Antwerp, he studied there and in Paris. Charles Le Brun, the virtual dictator of the arts of Paris, nominated Edelinck as a teacher in the Royal School of the Gobelins. One of Edelinck's best-known prints is the *Portrait of Philippe de Champaigne.*

S. W. Hayter

EDELWEISS, *AY dul vise,* is an attractive flower which grows in the mountain regions of Europe, Asia, and South America. The edelweiss plant has long, narrow, sage-green leaves, and grows from 4 to 12 inches tall. From the leaves grow white, star-shaped flowers.

The edelweiss can be cultivated in gardens in cool regions of America and Europe. In its native countries the edelweiss is considered a rare plant, because it grows wild in high regions and is difficult to obtain.

Scientific Classification. The Alpine edelweiss belongs to the family *Compositae.* It is genus *Leontopodium,* species *alpinum.*

Paul C. Standley

See also Flower (color picture, Alpine Flowers).

EDEMA, *ee DEE muh,* is the abnormal collection of fluid in body tissues. Sometimes the word *edema* is used as a synonym for *dropsy.* But doctors use dropsy more often as a more general term to mean fluid accumulation in body cavities, as well as in tissues. See also Dropsy.

Brown Bros.

Adam and Eve Were Driven from the Garden of Eden by an angel, as shown in a Biblical illustration by Gustave Doré.

EDEN was a region described in the Bible as the place where God created a garden for Adam and Eve. The name comes from a Sumerian word that means *plain.* Chapter 2 of Genesis tells that the garden contained beautiful fruit-bearing trees, and the tree of life and tree of knowledge. A river flowed from the garden, and divided into four streams. Two of these are supposed to be the Tigris and Euphrates rivers. The other two, called Pison and Gihon, have not been identified, but may be the Nile River and the Persian Gulf. The Bible describes how the serpent tempted Eve in the garden, and she and Adam ate forbidden fruit. Because of this, they were driven out and earned their living by hard work. See also Adam and Eve. W. W. Sloan

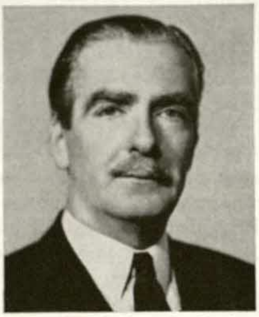
Edelweiss Is the National Flower of Switzerland. Its name is from a German word which means "noble white."

J. Horace McFarland

EDEN, SIR ANTHONY (1897-), a British statesman, served as Prime Minister of Great Britain and leader of the Conservative party from 1955 to 1957. Eden succeeded Winston Churchill as prime minister in 1955. He was largely responsible for Britain's decision to join France in attempting to seize the Suez Canal in October, 1956, after Egypt had seized and nationalized it in July. He was criticized greatly for this. Under United Nations pressure, a cease-fire was quickly arranged (see Suez Canal [History]). Eden resigned in January, 1957, because of poor health.

Eden was born in Durham. During World War I, he spent two years on the French front. After the war, he studied at Oxford University and was graduated in 1922. Eden entered parliament in 1923. He became foreign secretary in 1935, but resigned in 1938 in protest against Prime Minister Neville Chamberlain's appeasement of the Italian dictator, Benito Mussolini.

In Churchill's World War II government, Eden again served as foreign secretary, from 1940 to 1945. He held this office a third time in Churchill's government of 1951 to 1955. Queen Elizabeth II made Eden a Knight of the Garter, the highest order of British chivalry, in 1954. C. L. Mowat



British Information Services

Sir Anthony Eden

EDENTATE, *ee DEHN tayt*, is among the lowest groups of mammals. It is a group usually provided with hooklike claws, and small, poorly developed brains. The word *edentate* means *toothless*, but many of these animals have teeth. Edentates are found throughout the world, but are most common today in South America. Common edentates are the anteater, armadillo, and sloth.

Scientific Classification. Edentates are in the class *Mammalia*. They form the order *Edentata.* William C. Beaver

See also Aardvark; Anteater; Armadillo; Ground Sloth; Sloth.

EDERLE, *AY der lee*, **GERTRUDE CAROLINE** (1907?-), an American swimmer, was the first woman to swim the English Channel, and the first swimmer to do it using a crawl stroke. She made the crossing in 14 hours, 31 minutes, on Aug. 6, 1926. Her time broke the existing men's record. Miss Ederle was born in New York City. She won her first distance race, a three-mile swim in New York Bay, at the age of 14. She held five separate women's swimming titles in 1923. Pat Harmon

EDGERTON, HAROLD EUGENE (1903-), is an American electrical engineer who invented a device that revolutionized photographic technique. In 1929, he invented an electric lamp, now known as the *electronic flash*, that could be flashed intermittently for use in high-speed and stroboscopic photography. During World War II, he built an electronic flash bright enough to permit aerial photographs to be taken at night at an altitude of more than a mile. Edgerton was born in Fremont, Neb. Beaumont Newhall

EDGERTON, SIDNEY. See MONTANA (Famous Montanans).

EDGEWOOD COLLEGE OF THE SACRED HEART is a Roman Catholic college for women at Madison, Wis. It is conducted by the Dominican Sisters. Edgewood is primarily a teachers college. It was founded in 1927. For enrollment, see UNIVERSITIES AND COLLEGES (table).

EDICT OF NANTES. See NANTES, EDICT OF.

EDICT OF RESTITUTION. See THIRTY YEARS' WAR (The Danish Period).

EDINBORO STATE COLLEGE is a coeducational state teachers college at Edinboro, Pa. Courses in art education and teacher training lead to bachelor's degrees. The school also offers preparatory courses for dental hygienists and school nurses. It was founded in 1857. For enrollment, see UNIVERSITIES AND COLLEGES (table).

EDINBURGH, *EHD in BUR uh* (pop. 466,900; alt. 195 ft.), the capital and second largest city of Scotland, is picturesquely situated on the hills south of the Firth of Forth. It was named in honor of Edwin of Northumbria, an Anglian king who built a fort there in the 600's. For location, see SCOTLAND (map).

The city's main thoroughfare is famous Princes Street. On one side stand many of the great buildings of Scotland, and on the other is a ravine, used as a throughway by the railroad. Princes Street Gardens, famous for their flower clock, are also located here. Across the ravine is historic Castle Rock, with Edinburgh Castle on top of it. The Royal Mile leads from this castle to Holyrood Castle (see HOLYROOD). Along the Royal Mile stand the Norman Chapel of Saint Margaret, which was built about 800 years ago, and old Saint Giles' Cathedral.

Edinburgh is often poetically called *Dunedin*, the Gaelic form of its name. It has been important as a cultural and educational center for centuries, and has few industries. The University of Edinburgh, one of the oldest schools in the world, and the Royal High School, were founded in the 1500's. The Advocate Library, where the philosopher David Hume was once librarian, was founded in 1682. Important art collections are housed in the Royal Scottish Academy, the Royal Scottish Museum, and the National Gallery of Scotland. The Edinburgh music, drama, and film festival has attracted exhibitors from every country.

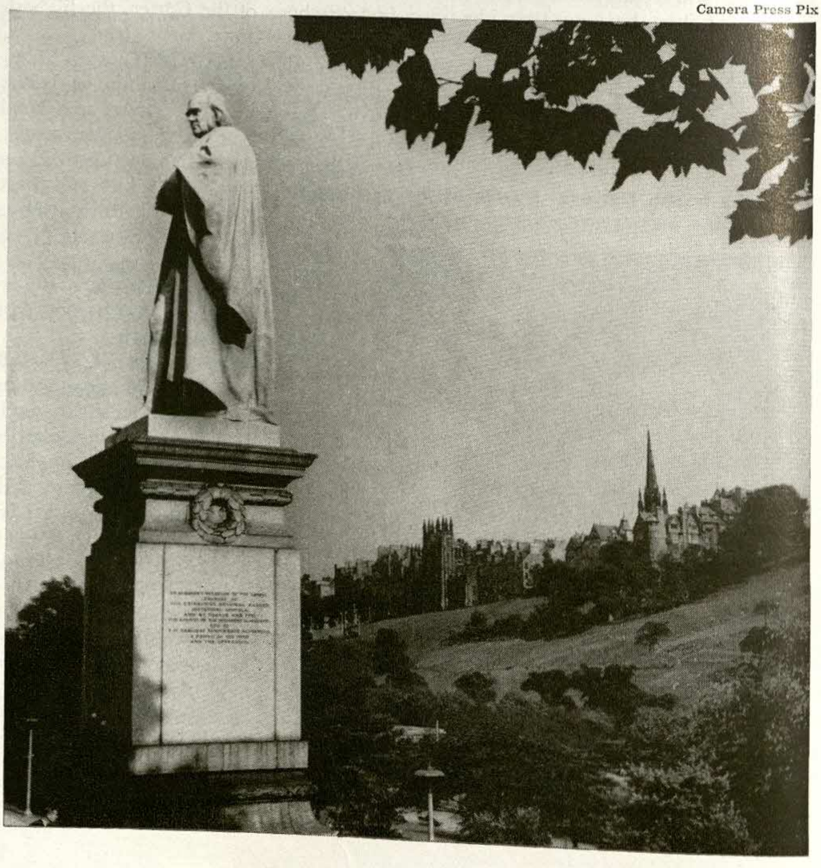
The publishing houses of Edinburgh have sponsored well-known magazines, including the *Edinburgh Review* and *Chambers Edinburgh Journal*. *Chambers Encyclopedia* and the *Book of Days* were also published in this city. Several famous writers, among them Sir Walter Scott, Robert Burns, and Thomas de Quincey, achieved success here. John Knox, who led the Protestant Reformation in Scotland, lived there.

WILLIAM A. HANCE

EDINBURGH, DUKE OF. See PHILIP, PRINCE.

EDINBURGH, UNIVERSITY OF, is one of the oldest and most famous coeducational institutions of higher learning in Great Britain. It was founded in Edinburgh, Scotland, in 1583. The chief faculties, or divisions, are arts, science, agriculture, medicine, law, music, and divinity. Enrollment is about 6,500.

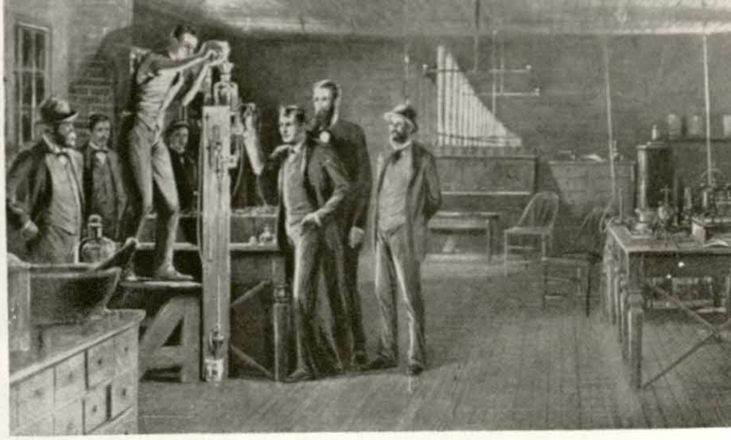
EDIRNE. See ADRIANOPLE.



Camera Press Pix

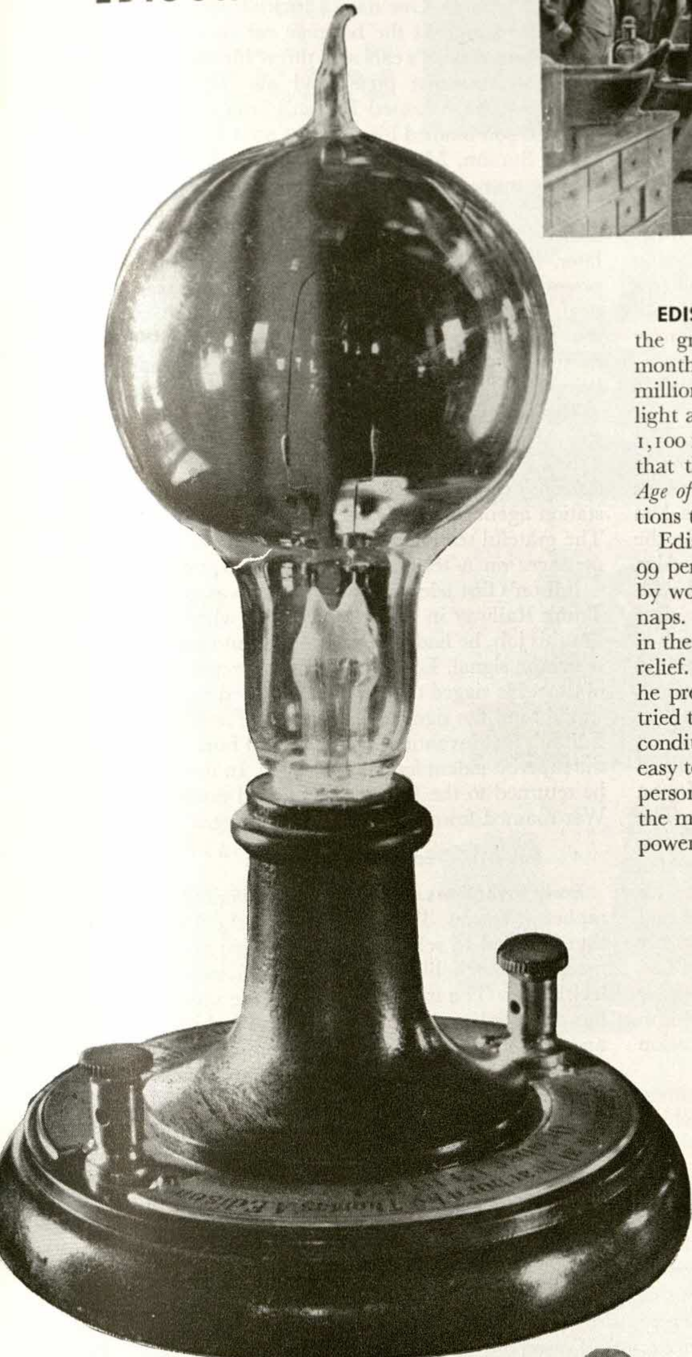
Spires of Edinburgh tower over a grassy hill that slopes down to famed Princes Street, the city's main thoroughfare. The statue, *right*, honors Thomas Guthrie, a Scottish clergyman.

THOMAS EDISON



EDISON, THOMAS ALVA (1847-1931), was probably the greatest inventor in history. He had only three months of formal schooling, but he changed the lives of millions of people with such inventions as the electric light and the phonograph. Edison patented more than 1,100 inventions in 60 years. Henry Ford once suggested that the period of Edison's life should be called *The Age of Edison*, because of the inventor's great contributions to mankind.

Edison defined genius as "1 per cent inspiration and 99 per cent perspiration." He demonstrated this belief by working for days at a time, stopping only for short naps. Everything interested Edison. He experimented in the field of medicine, and offered a program for farm relief. He came close to the invention of the radio, and he predicted the use of atomic energy. Edison always tried to develop devices that would work under ordinary conditions, could not easily get out of order, and were easy to repair. He also improved the inventions of other persons. These included the telephone, the typewriter, the motion picture, the electric generator, and electric-powered trains.



Thomas Edison, "the Wizard of Menlo Park," was probably the world's greatest inventor. The drawing, *above right,* shows Edison testing his greatest invention, the electric light. His first light bulb, shown in replica, *above,* used sewing thread as a filament. Edison, *right,* also invented the phonograph and helped perfect motion pictures, the telephone, and the electric generator.

Courtesy of National Park Service

EDISON, THOMAS A.

Edison once admitted that he "tried everything" while working on his inventions. He generally ignored scientific theory and mathematical study that might have saved him time. But failure never discouraged him. When about 10,000 experiments with a storage battery failed to produce results, a friend tried to console him. "Why, I have not failed," Edison said. "I've just found 10,000 ways that won't work."

Early Life

Boyhood. Edison was born on Feb. 11, 1847, at Milan, Ohio. He was the seventh and youngest child of Samuel and Nancy Elliott Edison. His father had become a prosperous shingle manufacturer after fleeing from Canada during the Rebellion of 1837-1838 (see REBELLION OF 1837-1838).

The great curiosity of the youngster—his family called him Alva or Al—led him to ask questions constantly. "How does a hen hatch chickens?" "What makes birds fly?" "Why does water put out a fire?" His mother had once been a schoolteacher, but even she could not answer some of his questions. If no one answered his questions, he would try to get the answers by experiment. For example, he noticed that a hen hatched chicks out of eggs by sitting on them. So the boy collected some eggs and sat on them! One day Alva learned that balloons fly because they are filled with gas. He persuaded another boy to take a triple dose of Seidlitz powders (see SEIDLITZ POWDERS). Alva was sure that as the boy's stomach filled with gas, he would start flying. Instead, Alva's friend lay ill on the ground, while the world seemed to whirl around him.

At the age of 7, Alva moved with his parents to Port Huron, Mich., where his father established a grain and lumber business. Alva entered public school and soon irritated his teacher by asking so many questions. The schoolmaster used a heavy strap to whip the boys, especially those who asked questions. One day Alva heard the schoolmaster tell the district school inspector that the Edison boy was "addled." Alva ran home and told his mother. She went directly to the schoolmaster and told him in no uncertain terms that Alva "had more sense in his little finger" than the schoolmaster had in his whole body, and that she was taking him out of school. Thus, young Edison's formal education lasted only three months.

Mrs. Edison had the notion, unusual for those times, that learning could be fun. She made a game of teaching him—she called it exploring—the exciting world of knowledge. The boy was surprised at first, and then delighted. Soon he began to learn so fast that his mother could no longer teach him.

When Alva was 9 years old, Mrs. Edison bought him a chemistry book by Richard G. Parker, a well-known teacher of the mid-1800's. Edison would not accept as true the statements made in the book. He tested every experiment himself to try to prove the author wrong. Alva had more than 100 bottles containing various chemicals. He labeled them all "Poison" to keep his family away from them.

At the age of 12, the boy took a job as "news butcher" on the Grand Trunk Railway. He sold newspapers, candy, sandwiches, and peanuts on a train that ran between Port Huron and Detroit. In his spare time, he experimented with chemicals in the baggage car. He even printed a newspaper, the *Weekly Herald*, the first newspaper to be published on a moving train.

However, Al's chemical experiments on the train got him into trouble. One day, a stick of phosphorus burst into flames and set the baggage car on fire. The conductor boxed Alva's ears and threw him off the train—chemicals, printing press, and all. The conductor's blows may have caused Edison's later deafness. However, Edison blamed his deafness on a later incident at Fraser Station, Mich. When he struggled to board a moving train, a well-meaning conductor caught hold of the boy's ears to pull him up to the platform. "I felt something snap inside my head," Edison said years later. "My deafness started from that time and has progressed ever since." Edison never became completely deaf, although in his last years he could barely hear a shout. An operation could have cured his deafness, but he refused to undergo surgery. Edison did not mind being deaf, because he found it easier to concentrate.

The Young Telegrapher. After the fire in the baggage car, Alva sold newspapers at stations along the Grand Trunk Railway. One day, at the Mt. Clemens, Mich., station, Edison noticed a freight car rolling toward the station agent's son. Alva rescued the boy just in time. The grateful station agent taught him how to tap out messages on a telegraph key (see TELEGRAPH).

Edison's first telegraph assignment was on the Grand Trunk Railway in Ontario, Canada, when he was 16. On this job, he had to report to Toronto every hour by telegraph signal. Edison thought this reporting a waste of time. He rigged up a gadget attached to a clock that would send the signal even if he were asleep. This was Edison's first invention. It almost cost him his job when the superintendent found him asleep. In the fall of 1863, he returned to the United States, and during the Civil War roamed from city to city as a telegraph operator.

Edison's Inventions

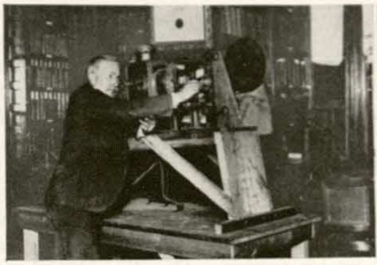
Early Inventions. In 1868, Edison worked as a telegrapher in Boston. There he perfected the first invention that he tried to sell. It was an electric vote-recording machine, much like those now used in several state legislatures. The machine recorded the votes of legislators on a big board. Edison took it to Washington, D.C., and tried to sell it to Congress. A committee gave him a hearing, but the chairman explained that such a device was the last thing the congressmen wanted. "It takes 45 minutes to call the roll," he explained to the young inventor. "In that time we can trade votes. Your machine would make that impossible." Congress still uses the old-fashioned roll-call method of voting, and for the same reason. Young Edison was annoyed by his treatment. "I will never again invent anything which nobody wants," he said. And he kept his word. From that time on, he devoted himself to what he called the "desperate needs of the world."

Edison drifted from Boston to New York City in 1869. He arrived nearly penniless, and persuaded an employee of the Gold Indicator Company, a stock-ticker firm, to let him sleep in the office. Edison spent much of his time studying the stock ticker, a telegraph device the company used to report the price of gold to brokers' offices (see STOCK TICKER). The ticker broke down a

EDISON'S GIFTS TO THE WORLD

MOTION PICTURES

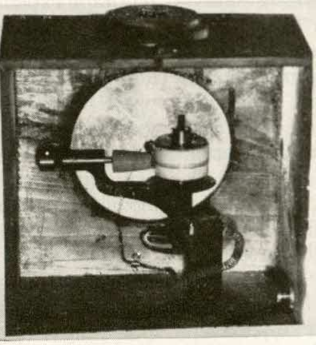
Edison invented one of the first successful motion-picture devices in 1889. He also contributed to the development of sound movies.



Owned by the Henry Ford Museum; Bell & Howell

THE TELEPHONE TRANSMITTER

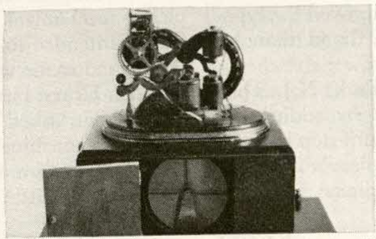
Edison's work on the carbon telephone transmitter helped pave the way for the modern telephone. The early transmitter shown here used chalk instead of carbon granules.



Owned by the Henry Ford Museum; Illinois Bell Telephone Co.

STOCK TICKER

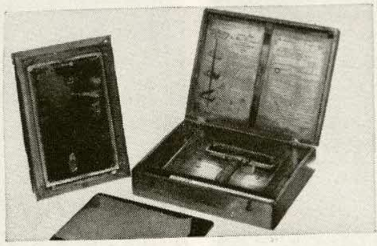
Edison patented improvements on the stock ticker that netted him his first large sum of money. In 1869, he sold his patents for the sum of $40,000.

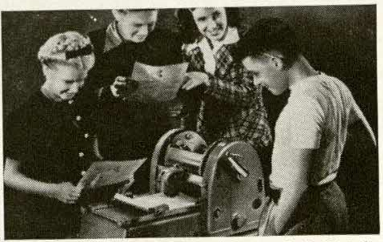


Owned by the Henry Ford Museum; Pickow, Three Lions

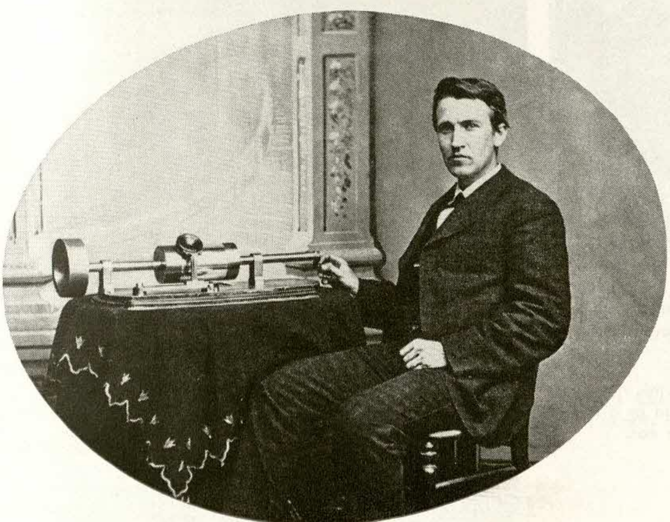
MIMEOGRAPH MACHINE

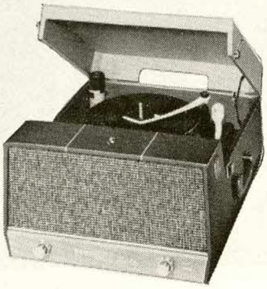
Edison invented the electric pen that was used on the first Mimeograph invented by A. B. Dick in the 1880's. The pen made perforations in the stencil. Today, typewriters do this job.





Owned by the Henry Ford Museum; A. B. Dick Co.





PHONOGRAPH

Edison called the phonograph, invented in 1877, his favorite invention. The photograph, *left,* shows Edison seated with his phonograph in 1878.

Courtesy of National Park Service; Zenith Radio Corp.

few days later, and Edison astounded the manager by fixing it after other persons had failed. The manager at once offered him the job of supervisor at $300 a month, a large salary at that time.

Edison's busy mind kept him experimenting on the stock ticker. He made improvements that interested General Marshall Lefferts, president of the Gold and Stock Telegraph Company. Lefferts sent for Edison and asked him how much he wanted for his various patents on the stock ticker.

Edison decided he might dare ask for $5,000, but would accept $3,000. Hesitating between the two figures, he said: "Well, General, suppose you make me an offer." Lefferts thought for a while and then said: "How would $40,000 strike you?"

For a moment, Edison had trouble getting control of himself. He seized the table to steady himself, and said slowly, "Yes, I think that will be fair."

The Wizard of Menlo Park. With the money he received from Lefferts, the 23-year-old Edison opened his first workshop in Newark, N.J. There he began to manufacture his improved stock ticker. In 1874, he improved the typewriter by substituting metal parts for wood. He also corrected the alignment of the letters and the distribution of ink. Until Edison improved the typewriter, a person could write faster by hand than he could on the machine.

In 1876, Edison moved to Menlo Park, N.J. That same year he improved the telephone by adding the carbon transmitter. This was an important step in making the telephone practical. Before Edison's improvement, people had to shout into the telephone.

The Phonograph. Edison's invention of the record player, or phonograph, in 1877 ranks as one of the world's most original inventions. No one had ever made a working model of a phonograph, and his model was absolutely new and different. Edison always regarded the phonograph as his favorite invention.

The idea for the phonograph came to him while he was trying to find a way to record telegraph messages automatically. He wanted to record the messages on a paper disk laid on a revolving plate. This disk would turn like the phonograph record of today. From his telegraph experiments Edison had learned how to make a *diaphragm*, or vibrating disk, that would respond to vibrations of sound. He made a toy with a funnel attached to a mechanism. At the end of it stood a paper figure of a little man with a saw. When Edison shouted "Mary had a little lamb" into the funnel, the man started to saw wood. Edison decided that he could make an exact record of these waves instead of just moving something. Then the words he said could be reproduced from such a record.

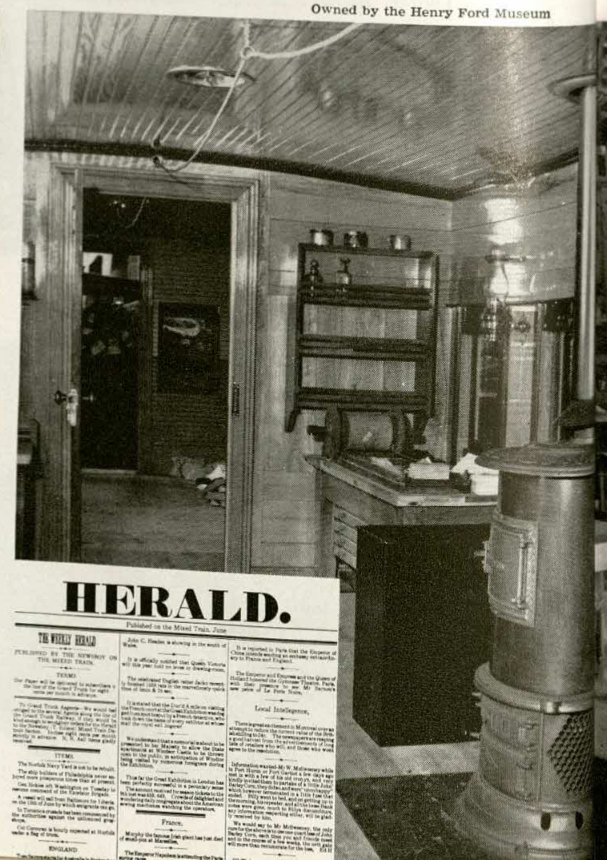
Edison made a sketch and gave John Kruesi, his shop foreman, a simple order: "Make this." Kruesi studied the sketch, but it puzzled him. It called for something neither chemical nor electrical, but mechanical. Edison did not usually invent something completely mechanical. Kruesi could not imagine what use Edison intended to make of the device. But he took the sketch and made what the drawing called for.

When Kruesi brought the cylinder gadget to Edison, the foreman asked what it was. Edison said casually, "Oh, this machine is going to talk." He wrapped a sheet of tin foil around the cylinder. Then he recited "Mary had a little lamb" into the mouthpiece of the

I. T. Frary

Thomas Alva Edison's Birthplace, *above*, was this red brick house at Milan, Ohio, where Edison was born on Feb. 11, 1847.

Owned by the Henry Ford Museum



HERALD.

Published on the Mixed Train, June

THE WEEKLY HERALD

PUBLISHED BY THE NEWSBOY ON THE MIXED TRAIN.

TERMS

ITEMS

ENGLAND

France.

Local Intelligence,

Edison's Baggage-Car Laboratory, shown in this restoration, *right*, was part of the train on which he worked as a boy. Edison printed a newspaper, *inset*, in the baggage car.

contraption. After one false start, the machine repeated Edison's words. Kruesi's face turned white as a sheet. Edison himself was surprised. See PHONOGRAPH.

The Electric Light. The invention of the electric light was not as original as the invention of the phonograph. Many others had been working on the idea for years. The Russian electrical engineer Paul Jablochkov (1847-1894) had lighted up the boulevards of Paris with arc lights in 1867 (see ARC LIGHT). But Edison wanted small lights that could be used in homes and offices. In short, he wanted a substitute for gas, the chief means of lighting at the time.

In 1879, Edison worked out a successful principle for the electric light. He had spent two years searching for the proper *filament*, or wire, that would give a good light when electricity flowed through it (see ELECTRIC LIGHT). In his search for a perfect filament material, he sent an agent into the jungles of the Amazon, and another into the forests of Japan.

One night, Edison sat at his desk, idly toying with a mixture of lampblack and tar. He noticed that when it was rolled out it looked like wire. He had tried everything else, even red hair from the beard of the station agent whose child he had saved years before. Edison twisted a thin strand of lampblack and tar, put it into a bulb, and drew out the air. When he turned on the current, the bulb glowed for a while and then burned out.

Edison decided that this mixture burned out because it contained air. He thought of trying something that did not contain air, like *carbonized thread*. This was ordinary cotton sewing thread burned to an ash. Edison thought it possible that this thread would stand an electric current.

On Oct. 19, 1879, after many failures, Edison finally succeeded in placing a filament of carbonized thread in a bulb. The bulb shed a good light. As dawn broke on the morning of October 20, the precious bulb still glowed. It burned all that day. Finally, at 1:30 P.M. on October 21, Edison decided to increase the voltage. Not until then did the bulb burn out.

On Dec. 21, 1879, news of Edison's invention of the electric incandescent light astounded the world. Edison became known in all countries as "The Wizard of Menlo Park."

Later Work. In 1887, Edison moved to a larger and more modern laboratory at West Orange, N.J. He spent most of his time perfecting his inventions of the 1870's. He also organized many companies to manufacture and sell his inventions.

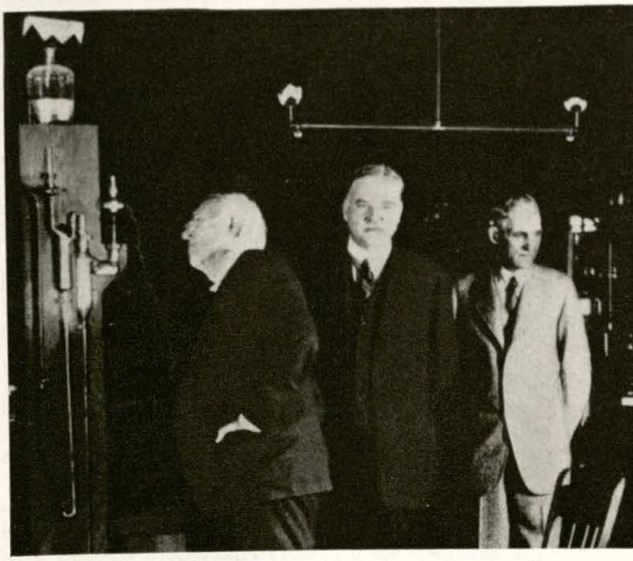
Edison contributed to the development of motion pictures in 1891. He invented a camera based on the inventions of George Eastman and other men (see MOTION PICTURE [The First Motion Pictures]).

As early as 1914, Edison connected the phonograph and camera to make talking pictures. The machine showed some faults and Edison put it aside. Other men later corrected these faults. At first, people regarded motion pictures as a kind of toy. But Edison hoped to see them used as a means of education. He predicted that some day they would replace other methods of teaching.

Some of his later inventions and improvements included the storage battery, a cement mixer, the dictaphone, and a duplicating machine. From his first patented invention, the vote-recorder, to the last, a method of making synthetic rubber from goldenrod plants,

Edison Electric Institute

Owned by the Henry Ford Museum



The Menlo Park Laboratory, *above*, has been reconstructed at Greenfield Village, Dearborn, Mich. Here, it was inspected in 1929 by, *left to right*, Edison, Herbert Hoover, and Henry Ford.

Edison's Last Laboratory, *left*, at West Orange, N.J., remains exactly as he left it. It is now a national monument.

Edison continued his contributions to society at a steady pace. He died at the age of 84 on Oct. 19, 1931, at West Orange.

Edison the Man

Family and Friends. Edison was married to Mary Stilwell in 1871. She died in 1884, leaving three children, Marion Estell, Thomas Alva, Jr., and William. In 1886, he married Mina Miller, daughter of Lewis Miller, an inventor, manufacturer, and philanthropist. The children of his second marriage were Charles, Madeleine, and Theodore. Charles Edison became Secretary of the Navy in 1939, and was elected governor of New Jersey in 1941.

Edison was not much of a family man. Both his wives complained that he spent most of his time in the laboratory. However, he did set aside July 4 to spend with his children and grandchildren. He celebrated this holiday in as noisy and spectacular a manner as possible.

The inventor never had any really close friends. He occasionally enjoyed the company of Henry Ford, Harvey Firestone, and John Burroughs. But he worked too hard and too many hours to have much time for friendships. Throughout Edison's life, his work remained his greatest joy and companion.

Personality and Philosophy. Edison was always strongly independent, and followed his own ideas. He claimed to have the same reaction to women and mathematics—he could not understand either. He loved practical jokes, although sometimes they backfired. Once he put a box of cheap, strong cigars on his desk so his co-workers could help themselves, as usual. However, he discovered later that he had smoked them all himself.

The inventor had a keen ear for music. In spite of his deafness, he often claimed he could hear "through the skull" by placing his head against a phonograph speaker. He personally supervised thousands of recordings, and could instantly detect a wrong note.

Edison was not a religious man, but he believed in a Supreme Intelligence. He once pointed out to a friend that although he was known around the world as a great inventor, he could not create the simplest form of life. The question of life after death fascinated Edison. In his later years, he told newspaper reporters several times that he was working on a device "so sensitive that if there is life after death it will pick up the evidence of it." But no model of such a machine, if ever developed, has been found in his laboratories.

His Place in History. Edison's major contribution to the world consisted not only in his invention of the electric light, but also in making it available to millions by designing the first electric-power station.

The golden anniversary of the electric light was celebrated on Oct. 21, 1929. For this jubilee, and to create a permanent shrine, Henry Ford moved Edison's original Menlo Park laboratory and its surroundings to Greenfield Village, a huge museum at Dearborn, Mich. (see GREENFIELD VILLAGE). In this setting, the 82-year-old Edison re-enacted the experiment that resulted in the first electric light.

Edison received so many awards for all his achievements that he once joked that he had to "measure them by the quart." The French government appointed him to the Legion of Honor. In 1920, the United States awarded him the Distinguished Service Medal for his work in connection with World War I. He had served as president of the Naval Consulting Board and conducted research on torpedo mechanisms and other devices. Congress awarded Edison a gold medal in 1928 for "development and application of inventions that have revolutionized civilization in the last century." Nations and individuals honored him as probably no other person has been honored while alive. In 1960, 29 years after his death, Edison was elected to the Hall of Fame for Great Americans at New York University in New York City.

Edison's birthplace at Milan, Ohio, was restored as part of a nationwide centennial observance during the week of Feb. 7, 1947. The restoration was done by the Edison Pioneers, an organization of the inventor's co-workers and associates. In July, 1956, President Dwight D. Eisenhower signed a proclamation making Edison's research laboratory at West Orange, N.J., a national monument. The National Park Service manages it as the Edison Laboratory National Monument. Glenmount, Edison's home at West Orange, was dedicated as a national historic site and placed under the National Park Service on Feb. 12, 1957.

HUGH RUSSELL FRASER

Related Articles in WORLD BOOK include:

Dictating Machine
Electric Generator
Electric Light
Electric Railroad (History)
Electronics (Early Experiments)
Invention
Motion Picture
Phonograph
Telephone (History)

Outline

- **I. Early Life**
  - A. Boyhood
  - B. The Young Telegrapher
- **II. Edison's Inventions**
  - A. Early Inventions
  - B. The Wizard of Menlo Park
  - C. Later Work
- **III. Edison the Man**
  - A. Family and Friends
  - B. Personality and Philosophy
  - C. His Place in History

Questions

How did Edison define genius?

What was Edison's first patented invention? How was it received? What was his last invention?

What was Edison's most original invention?

What invention of Edison's do you think was most important? Why?

Why did Edison enjoy being deaf?

How many inventions did Edison patent?

Why did Edison have few close friends?

Why did people call Edison "The Wizard of Menlo Park"?

How did Edison's work change the lives of millions of people?

Why did Edison attend school for only three months?

Books to Read

CLARK, G. GLENWOOD. *Thomas Alva Edison*. Dutton, 1950. A biography for young readers.

JOSEPHSON, MATTHEW. *Edison*. McGraw, 1959. This life of Edison also describes the technological changes brought about by his discoveries.

MEADOWCROFT, WILLIAM H. *Boy's Life of Edison: With Autobiographical Notes by Mr. Edison*. Harper, 1921. A member of Edison's staff wrote this biography.

NORTH, STERLING. *Young Thomas Edison*. Houghton, 1958. This book shows the character and personality of Edison through the story of his achievements.

EDISON INSTITUTE SCHOOL. See Greenfield Village.

EDISON LABORATORY NATIONAL MONUMENT covers 1.51 acres in Orange, N.J. It includes the original laboratory and library buildings of Thomas A. Edison. The monument was created in 1956. *Glenmont*, Edison's home in West Orange, is also part of the monument.

EDISON-LALANDE CELL. See Battery.

EDITION. See Newspaper (Newspaper Terms).

EDITOR. See Journalism; Magazine; Motion Picture (People Who Make Motion Pictures); Newspaper; Publishing.

EDITORIAL is usually a newspaper or magazine article that gives personal comments on current events. It may also be a radio or television broadcast. An editorial may criticize, or praise, or merely discuss the actions of some public official or group. In style, an editorial is much like an essay (see Essay).

The publisher of a newspaper or magazine, or the owner of a broadcasting station, usually gives his own personal views in an editorial. This practice is supposed to leave the news columns and broadcasts free from bias and personal opinion. Editorials usually appear in some clearly marked form, whether they appear on an editorial page or a news page.

Editors often use the newspaper editorial page to encourage movements that the paper thinks will benefit the community. For instance, a newspaper may back a campaign for more and better policemen in order to reduce a crime wave in its city. Such a campaign may begin with a news story or series of stories describing the need. Then frequent editorials urge action to improve the situation. Newspapers also use editorials to express strong political views.

Magazine editorials are similar to newspaper editorials, except that they usually discuss problems of national interest and scope.

An editorial usually begins by stating an issue or question based on the news of the day. It then interprets, explains, or appraises this issue or question. It may end with a conclusion in the form of advice, a plea, a command, or a summary. Gordon A. Sabine

EDMAN, IRWIN (1896-1954), was a philosopher and a professor of philosophy at Columbia University. He became widely known through his philosophical writings and his poetry. He was also highly regarded as a teacher. His chief philosophical interest was aesthetics. Among his best-known books are *Human Traits and Their Social Significance* (1920), *Poems* (1925), *Richard Kane Looks at Life* (1926), *Four Ways of Philosophy* (1937), and *Philosopher's Holiday* (1938). Edman was born in New York City. Eugene T. Adams

EDMONDS, WALTER DUMAUX (1903-   ), an American author, became known for his novel *Drums Along the Mohawk* (1936), and other books on the history of upstate New York. He won the Newbery medal in 1942 for his story for young people, *The Matchlock Gun* (1941). Edmonds was born on a farm near Boonville, N.Y. This is located near the old Erie Canal, which furnished the background for his first novel, *Rome Haul* (1929). Later, this novel was made into a successful play, *The Farmer Takes a Wife*, by Marc Connelly. Other works by Edmonds include *The Big Barn* (1930), *Erie Water* (1933), *Chad Hanna* (1940), and *The Wedding Journey* (1947). Frederick J. Hoffman

EDMONTON, *ED mun tun*, Alberta (pop. 226,002; met. area, 251,000; alt. 2,194 ft.), is the capital and largest city of the province. It ranks sixth in population among Canadian cities. Edmonton is called the *Gateway to the North*, because it serves as a main distributing point for goods transported to and from Alaska and northwestern Canada.

The city lies on rolling prairies in the heart of the Parklands, one of the richest agricultural regions in Canada. It is about 100 miles south of the center of Alberta. The winding North Saskatchewan River flows through Edmonton. The city covers nearly 45 square miles. For location, see Alberta (color map).

Industry and Commerce. Farms and large fields of coal, natural gas, and oil surround the city, which is one of Canada's chief oil centers. Hundreds of miles of pipelines carry petroleum into the city for processing. Chemical and plastics plants use by-products of the oil industry. Edmonton manufactures many kinds of synthetic fibers from natural gas. This gas is also used in the city's factories. It helps to keep Edmonton smoke-free.

Other manufactured and processed products include building materials, clothing, electrical supplies, feed, fertilizers, flour, forest products, glass products, meats, and textiles.

Transportation and Communication. Two transcontinental railways and several branch railways serve the city. The Edmonton Municipal Airport, established in 1919, was the first licensed commercial airport in Canada. Edmonton's International Airport began operations in 1960. There are five radio stations, two television stations, and three newspapers. The *Edmonton Journal* is the city's only daily newspaper.

Education. Edmonton is the home of the University of Alberta and several denominational colleges. The city has more than 70 public schools.

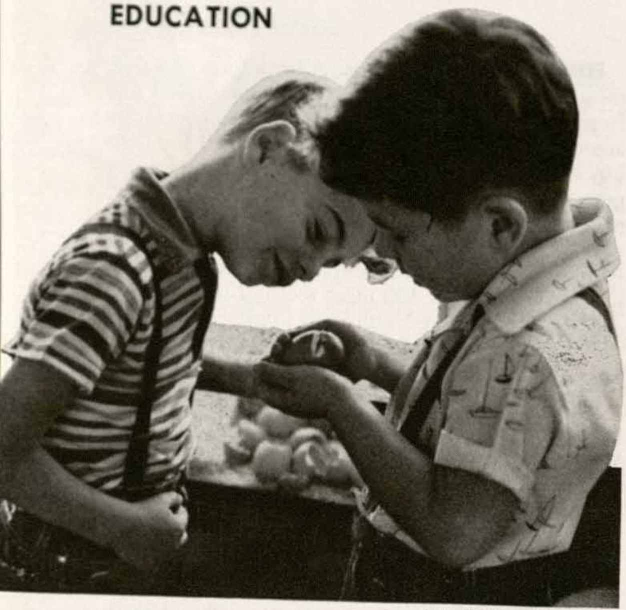
Interesting Places to Visit. Canada's only Moslem mosque stands in Edmonton. The city has an art museum, a symphony orchestra, a children's zoo, and nearly 2,000 acres of playgrounds and parks. The Jubilee Auditorium can seat 2,700.

History. In 1795, the Hudson's Bay Company established a fur-trading post on the North Saskatchewan River. It was named Fort Edmonton, after a suburb of London, England. In 1808, after Indians destroyed the original fort, a new Fort Edmonton was built on the present site of the city. Settlement began about 1870. The town of Edmonton was incorporated in 1892. Edmonton received its city charter in 1904, and a year later became the capital of the province of Alberta. Construction of the Alaska Highway in 1942 helped establish Edmonton as an important distribution center. The discovery of oil at nearby Leduc in 1947 led to great industrial expansion in Edmonton. Three refineries, many factories, and thousands of homes for new workers were built. The city has a mayor-council government. W. D. McDougall

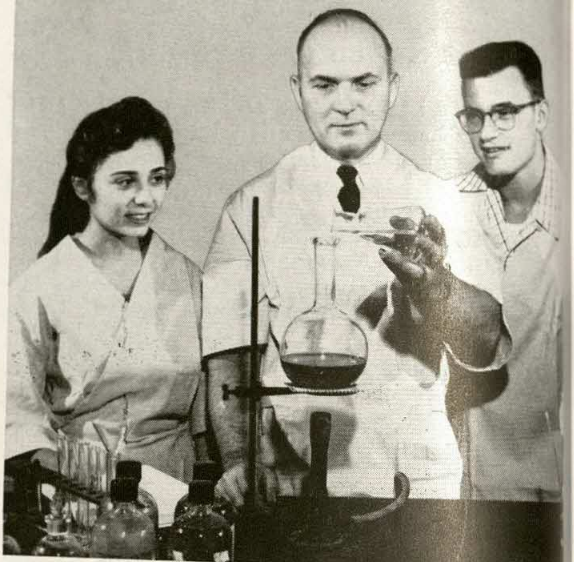
EDMUNDS, GEORGE FRANKLIN. See Vermont (Famous Vermonters).

EDMUNDS ANTI-POLYGAMY ACT. See Arthur, Chester Alan (Other Legislation).

EDSON, GUS. See Comics (The Gumps).



John Hamilton, Globe Photos



Ted Varner, Weirton Steel Co. Div. of National Steel Corp.

Seeing and Doing Make Education more meaningful to youngsters and teenagers. Watching an egg hatch, *left*, and helping perform an experiment, *above*, help create interest in students.

EDUCATION includes all the ways in which one person deliberately tries to influence the behavior of another person. Behavior may include knowledge, skills, habits, values, and attitudes. *Formal education* includes organized instruction given by teachers in such institutions as schools and universities. *Informal education* involves learning from people and agencies whose primary purpose is something other than organized instruction. These include the family and other social groups, as well as newspapers, television, and movies.

Parents educate children when they teach them to talk, to like and dislike things, and to behave in certain ways. Libraries and museums educate people by providing them with books and information in many fields of knowledge. Churches educate people when they urge them to accept certain beliefs about religion and personal conduct. Governments educate citizens by passing laws that require people not to injure each other and to respect the property of others.

In these and countless other ways, the people of every country learn the customs, knowledge, beliefs, and ideals of the groups in which they live. A people's whole way of life is called its *civilization* or its *culture*. Any civilization is a product of education. See CIVILIZATION; CULTURE.

A group of persons could not live together peacefully for any length of time unless they agreed to act in certain ways. The process by which they learn to act in these ways is education. A human society could not exist without education, and an individual could not be a member of society without being educated in the ways of that society. In fact, the level of life in any country rests upon the level of education of its people.

For the story of the development of education, see EDUCATION, HISTORY OF.

Purposes of Education

Most of us use the word *education* to mean the purposeful teaching and learning provided in schools and other formal institutions of education. The school as a specialized institution appeared about 3,000 or 4,000 years ago. At that time, certain persons who became known as teachers were gradually given the special task of educating children.

The schools of a particular society or country usually pass along the accepted customs, ideas, and beliefs of that society. Through the years, schools have had several important aims. These include: (1) acquisition of knowledge, (2) intellectual discipline, (3) education for citizenship, (4) individual development, (5) vocational training, and (6) character education.

Knowledge. Schools have always insisted that students acquire the knowledge, information, and skills that are important for an educated person. Students are taught to read and write one or more languages, to use a system of numbers, and to acquire knowledge of such subjects as history, literature, and science. Testing whether a person has memorized and can repeat information is the easiest way to determine whether or not he has learned something. But an important part of a useful education is applying knowledge to daily life.

Intellectual Discipline has had different meanings through the years. But it has usually meant that schools have tried to teach students to think and to reason things out, rather than simply to rely on their guesses, desires, or emotions. The ability to think and reason logically is one important way in which human beings differ from animals. Schools stress learning activities that develop the power of reasoning. Studying and solving problems in a variety of subjects help students improve their reasoning ability.

Citizenship. The study of history, geography, social sciences, and literature helps develop social and civic responsibility in students. In dictatorships, such as that of Communist Russia or Nazi Germany, schools require obedience to the doctrines of the government. Schools in democratic countries try to encourage students to think for themselves. In Canada, the United States, and western Europe, for example, students take part in democratic activities as one means of learning citizenship. See CITIZENSHIP (Education for Citizenship).

Individual Development. The well-rounded development of any person calls for attention to his physical, social, and emotional life, as well as to his intellectual growth. Healthful recreation, artistic appreciation, and the ability to express oneself in the arts are important for self-development.

Vocational Training. The schools of many countries prepare young people directly for earning a living in a wide range of occupations. Schools do this by on-the-job training and by shopwork, commercial courses, agricultural courses, and scientific, technical, and industrial courses. See VOCATIONAL EDUCATION.

Character. One of the most common purposes of schools in almost every civilization has been to develop in young people the kind of moral behavior desired by the adults of that society. This aim is often called *character education* (see CHARACTER EDUCATION). For hundreds of years, schools have taught honesty, truthfulness, justice, obedience, respect for law and order, and a sympathy for the welfare of others. The various religions of the world support such moral values. Many religious leaders have argued that good moral behavior is impossible unless it is based upon the doctrines of their particular faiths. Depending on the society, the ideal for moral education has been Christian, Jewish, Islamic, Hindu, Buddhist, or Confucianist in character. In countries that have no dominant religion, public schools include character education without reference to the religious teaching of any specific church. In the United States, for example, character education in public schools is not linked with any single religious teaching. Educators emphasize moral values that are common to all religions, including honesty, truthfulness, and respect for other people.

Various Views on Education

Education has always been influenced by various points of view. These viewpoints represent different ways of answering important questions or problems in education. These questions include the following: What are the major goals of education? What are the most important subjects to teach in the schools? How should a school program be organized? What teaching methods should be used? Should schools try to educate all children or just a few? How should teachers be trained? The systematic and consistent set of answers given to such questions form what is sometimes called a philosophy or theory of education.

Unlike many other countries, the United States has no central agency which dictates the kind of school program to be organized in all communities. Therefore, many different educational theories and practices exist throughout the country. But two major points of view are sometimes called the *progressive* and the *conservative*.

Progressive educators in the early 1900's tried to reform the traditional schools of the 1800's. Educators in this group wanted to expand elementary and high-school programs and improve teaching practices. They insisted that art, music, citizenship, home arts, and vocational training were important parts of education, along with the academic studies. They also wanted school programs flexible enough to make maximum use of the varying abilities of all children. These educators experimented with different ways to teach subject matter, attitudes, and skills in relation to their use in life-like situations. These situations might include studying the operation of local government or analyzing problems of conservation.

Progressive educators objected to the excessive use of textbooks, formal lectures, and memorizing. They wanted students to become more actively involved in their lessons. Progressive teachers use field trips, films, newspapers, and a wide range of books to supplement the study of textbooks and to encourage student initiative. The training of these teachers involves careful study of the practices and principles of professional education as well as a broad general education. See PROGRESSIVE EDUCATION.

Conservative educators stress the importance of organized knowledge in schools. They believe that schools exist primarily to transmit systematic knowledge. They also think that the best way to do this is to devote a large share of elementary education to "the 3 R's"—reading, writing, and arithmetic. They believe that high schools should stress the teaching of academic courses in history, English, mathematics, science, and foreign languages. These courses, according to conservative educators, develop disciplined minds. Courses in art, music, home arts, and vocational education are often considered "frills" by these educators.

The teacher's main job in a conservative school is to present subject matter clearly and to expect the students to work hard to achieve high standards. This point of view emphasizes the liberal arts and traditional subject matter in the training of teachers, with less attention given to teaching methods or educational theory.

The Educative Process

How People Learn. When a person's behavior changes, he has learned something. He may learn outside of school as well as in school. A child may learn words and sentences so that he can communicate with others. A person may learn to walk, to run, to jump, or to handle tools and operate a machine. He may learn attitudes of liking or disliking, loving or hating. He may learn facts such as that $4 + 4 = 8$, or that the Declaration of Independence was adopted in 1776. He may learn to deal with other persons courteously and fairly, or rudely and violently.

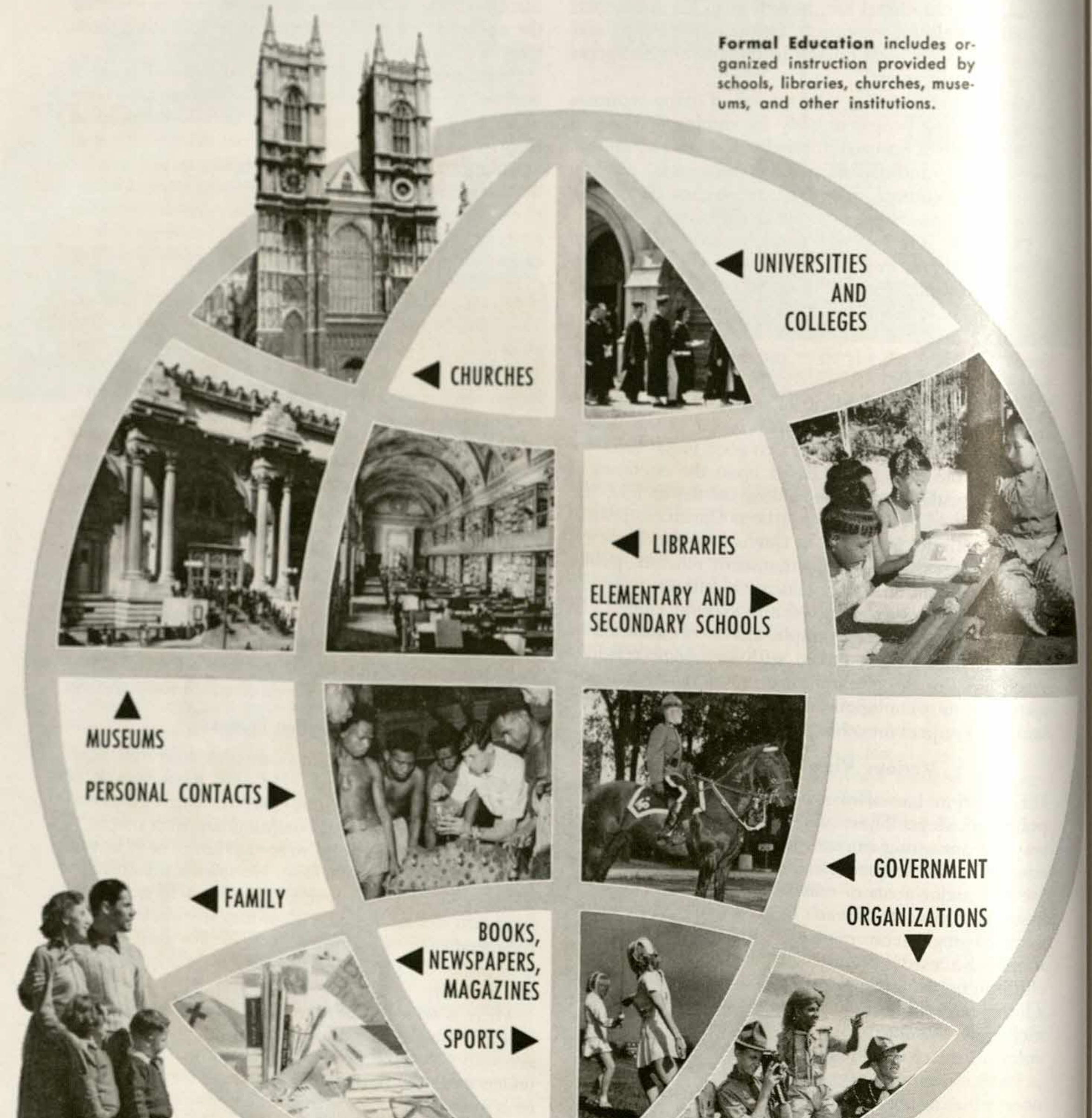
There is no absolute agreement among psychologists on the nature of human learning. But certain ideas are generally accepted. A person learns better when he understands the reasons for learning something, when he is motivated to learn, and when he works to achieve some goal that is important to him. If a child studies geography so that it has meaning and use for him, he may like the subject and perhaps do much work and study on his own. But if geography represents a collection of unrelated facts that a child is forced to memorize, he is apt to dislike the subject and even consider it worthless. Thus, several things may be learned at once. A person learns attitudes as well as facts. He learns feelings as well as actions. See LEARNING.

How Teachers Guide Learning. Teachers encourage learning by (1) persuading students to try to learn, (2)

THE WORLD OF EDUCATION

Education results whenever one person influences the knowledge of another person. Nearly all activities in a person's life tend to increase his knowledge. Educators often refer to these many influences as *formal* and *informal* sources of education.

Formal Education includes organized instruction provided by schools, libraries, churches, museums, and other institutions.



Informal Education comes from the family and from persons and agencies not mainly engaged in formal instruction.

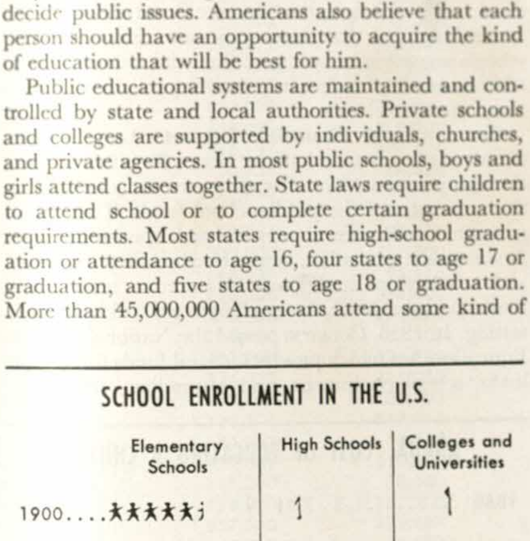
relating the material to situations that have meaning for the learners, (3) providing opportunities for learners to apply the new material to actual problems, and (4) testing students to see how well they have learned. The good teacher also provides practice sessions to assure student mastery of correct learning. One of the most important tasks of the teacher is to help students develop their own initiative and ability to think critically. Good teachers guide students in seeking important knowledge and analyzing possible solutions to meaningful problems. Skillful teachers also help students understand important values involved in dealing with various problems. See TEACHING.

Educational Institutions in the United States

The American people have great faith in the value of education. They believe that a democratic society rests upon the wisdom and intelligence of all the people. They believe that all the people must be educated so they can make intelligent decisions when they vote and decide public issues. Americans also believe that each person should have an opportunity to acquire the kind of education that will be best for him.

Public educational systems are maintained and controlled by state and local authorities. Private schools and colleges are supported by individuals, churches, and private agencies. In most public schools, boys and girls attend classes together. State laws require children to attend school or to complete certain graduation requirements. Most states require high-school graduation or attendance to age 16, four states to age 17 or graduation, and five states to age 18 or graduation. More than 45,000,000 Americans attend some kind of school, college, or university. Another 50,000,000 take part in some kind of adult education.

SCHOOL ENROLLMENT IN THE U.S.



Each symbol stands for 3,000,000 enrolled pupils.

Based on official government statistics.

Pre-Elementary Education. Some cities and many private agencies, such as church groups and women's clubs, operate nursery schools for young children from 2 to 4 years old. The program includes play activities, drawing, painting, singing, and dancing. Much attention is given to developing good health habits of cleanliness, eating, and resting. Most city school systems and many private agencies conduct kindergartens for 4- and 5-year-olds. In addition to more advanced play activities, kindergartens give attention to storybooks and storytelling, and to the arts and crafts. Readiness activities are often provided in reading, writing, and arithmetic to help prepare children for more formal learning in the elementary school grades. See NURSERY SCHOOL; KINDERGARTEN.

Elementary Education. Most children begin "regular" school in first grade at about 6 years of age. Some elementary schools have six grades, and others have eight. The first three or four grades give major attention to reading, writing, arithmetic, science, and the social studies. They also continue music, art, and physical education. The last three or four grades of elementary school put greater emphasis on the social studies, science, and literature.

Nearly all children between the ages of 6 and 14 attend elementary school. The great increase in the number of children during the late 1950's resulted in shortages of adequate classrooms and well-prepared teachers. More than 33,000,000 children attended elementary schools in 1960. See ELEMENTARY SCHOOL.

Secondary Education. There are two main kinds of secondary schools: (1) the four-year high school consisting of grades 9 through 12, and (2) the junior high school (grades 7 through 9) followed by the senior high school (grades 10 through 12). About 85 of every 100 boys and girls between the ages of 14 and 17 years attend secondary schools. This is a much higher proportion than in any other country. More than 9,000,000 boys and girls attended secondary schools in 1960.

Most secondary schools offer courses in English, foreign languages, the social studies, mathematics, science, art, and music. Many of these schools also provide technical, vocational, commercial, home economics, and industrial arts courses. Such schools are called *comprehensive schools*, because they are designed to meet the needs of all the youth in the community. Some large cities in the United States operate special *vocational schools*, which include trade schools, evening schools, and part-time schools. See HIGH SCHOOL; JUNIOR HIGH SCHOOL.

Higher Education. Institutions of higher education in the United States include (1) more than 500 two-year junior colleges, (2) about 300 technical and professional schools, (3) some 200 teachers colleges, (4) nearly 700 four-year liberal arts colleges, and (5) over 130 universities that offer undergraduate, graduate, and professional courses. About two thirds of the 1,800 institutions of higher education are privately controlled. But more than half the college and university students attend public institutions. Over 3,500,000 young people, or almost a third of the youth between 18 and 21, attended institutions of higher learning in 1960. See Junior College; Universities and Colleges.

Educational Programs in the United States

The courses of study offered by all educational institutions have greatly increased in both number and kind since the mid-1800's. Many new fields of knowledge, new occupations, and new demands upon education have made this expansion necessary.

General and Liberal Education. Most elementary schools, secondary schools, and undergraduate colleges give major attention to general and liberal education. Courses are designed to help the student become a well-informed citizen and to develop his physical, mental, personal, and moral capacities. These courses include the social sciences, languages, literature, the arts, mathematics, and the biological and physical sciences. University graduate schools provide the most advanced study and research in these fields.

Vocational, Technical, and Professional Education. Many high school students can prepare themselves directly for earning a living. Vocational courses in various types of trades, industry, business, and agriculture are offered by many high schools and vocational schools. The Smith-Hughes Act of 1917 greatly aided vocational education by providing grants to the states to help train teachers in agricultural, trade, home economics, and industrial subjects. These grants also help pay the salaries of qualified teachers of vocational subjects. See Smith-Hughes Act.

More advanced technical or semiprofessional courses in such fields as engineering, agriculture, electronics, nursing, and secretarial work are offered by junior colleges and technical institutes. Professional courses in medicine, law, teaching, engineering, architecture, theology, and business administration may be taken at universities or at separate professional schools.

Special Education. Special schools or special classes in regular schools help students who have physical, intellectual, or emotional difficulties. These include programs for the crippled, the blind, the deaf or hard of hearing, the mentally retarded, the emotionally disturbed and maladjusted, and the delinquent. The federal and state governments support vocational rehabilitation programs to help the handicapped care for themselves and prepare themselves for jobs.

Many school systems provide special classes for the intellectually gifted. Some schools offer these students special enrichment activities within the regular classrooms. A few school systems, such as that of New York City, provide special schools for children with unusual abilities in such fields as science and art.

Guidance and Personnel Services. Most schools and colleges have counselors who help students make wise choices of academic and vocational courses. They also have testing programs that include aptitude, interest, personality, and achievement tests. Psychologists and guidance specialists help students with particular difficulties such as emotional disturbances or learning problems. Health examinations, nursing, and medical services are available in most schools. See Guidance; Tests and Measurements.

Adult Education. Schools, universities, museums, libraries, community agencies, radio and television stations, and national organizations provide classes for about 50,000,000 American adults. These classes include Americanization and literacy courses for the foreign-born, courses that encourage hobbies and other recreation during leisure hours, courses in the liberal arts, vocational courses, and courses for personal, family, and civic improvement. See Adult Education.

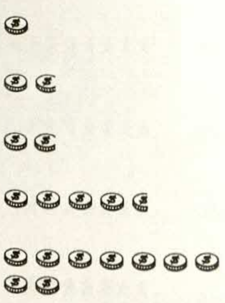
Control and Support of U.S. Education

State governments have general authority over public education in the United States. The legislature and department of education of each state establish regulations concerning attendance, buildings, curricula, and teachers' qualifications. Some state departments of education also select the textbooks to be used at various grade levels. Schools are managed in local districts by elected or appointed boards of education, superintendents, and administrative staffs. The United States Constitution limits the powers of the states and the local districts. For example, the Supreme Court of the United States has ruled that states may not segregate public schools according to race, give financial aid to religious schools, or aid churches in promoting religious instruction in public schools.

Governmental Financial Support. Local school boards raise more than half the money for public schools through property taxes. The state governments provide the remainder of the public-school funds. The federal government allocates money for such special purposes as vocational education, veterans' educational benefits, and scholarships and loans to improve teaching in mathematics, science, foreign languages, guidance, and testing. In 1958, Congress passed the National Defense Education Act which provides federal funds for student loans, school equipment, and counseling and testing

ANNUAL COST OF EDUCATING A CHILD

1880	$ 7.91
1890	11.04
1900	13.87
1910	23.93
1920	48.02
1930	89.84
1940	91.64
1950	231.05
1960 (est.)	450.00



Each symbol ● stands for $50 a year for educating one child in elementary and high schools in the United States.

Based on latest available statistics.

TEACHERS AND STUDENTS IN PUBLIC SCHOOLS

	NUMBER OF STUDENTS			NUMBER OF TEACHERS		
UNITED STATES	Elementary Kindergarten - 8	Secondary 9 - 12	TOTAL	Elementary Kindergarten - 8	Secondary 9 - 12	TOTAL
Alabama	482,000	321,250	803,250	15,675	11,820	27,495
Alaska	35,000	7,400	42,400	1,350	475	1,825
Arizona	256,500	73,500	330,000	9,121	3,067	12,188
Arkansas	240,701	182,339	423,040	8,017	6,478	14,495
California	2,460,000	1,140,000	3,600,000	74,500	44,750	119,250
Colorado	242,759	137,741	380,500	9,300	7,100	16,400
Connecticut	343,000	137,000	480,000	11,750	7,600	19,350
Delaware	47,572	34,634	82,206	1,977	1,711	3,688
District of Columbia	80,425	40,679	121,104	2,593	1,782	4,375
Florida	647,520	437,727	1,085,247	21,371	16,762	38,133
Georgia	677,596	291,503	969,099	21,332	12,163	33,495
Hawaii	85,409	59,283	144,692	2,900	2,000	4,900
Idaho	96,118	71,607	167,725	3,500	2,800	6,300
Illinois	1,324,366	426,413	1,750,779	49,108	23,006	72,114
Indiana	775,000	243,000	1,018,000	21,801	14,534	36,335
Iowa	394,620	203,335	597,955	14,903	11,361	26,264
Kansas	376,000	117,000	493,000	12,740	8,073	20,813
Kentucky	487,836	179,884	667,720	15,730	7,769	23,499
Louisiana	559,000	155,000	714,000	15,956	10,642	26,598
Maine	155,898	48,885	204,783	5,609	2,566	8,175
Maryland	358,022	249,341	607,363	12,305	11,215	23,520
Massachusetts	576,000	327,000	903,000	20,540	14,930	35,470
Michigan	1,028,537	636,203	1,664,740	37,500	27,076	64,576
Minnesota	420,000	280,000	700,000	15,400	13,350	28,750
Mississippi	457,000	118,000	575,000	10,619	7,381	18,000
Missouri	636,197	204,526	840,723	21,280	9,740	31,020
Montana	100,636	44,200	144,836	4,479	2,400	6,879
Nebraska	195,000	88,000	283,000	9,595	4,440	14,035
Nevada	57,100	15,150	72,250	1,686	1,033	2,719
New Hampshire	72,384	33,322	105,706	2,549	1,671	4,220
New Jersey	700,000	350,000	1,050,000	28,280	18,070	46,350
New Mexico	146,638	95,115	241,753	5,031	3,920	8,951
New York	1,726,000	1,184,000	2,910,000	66,100	54,000	120,100
North Carolina	850,000	270,000	1,120,000	26,911	10,547	37,458
North Dakota	101,000	36,800	137,800	4,500	2,130	6,630
Ohio	1,331,900	626,782	1,958,682	42,350	33,225	75,575
Oklahoma	324,000	215,000	539,000	11,720	8,970	20,690
Oregon	294,795	102,503	397,298	11,117	4,616	15,733
Pennsylvania	1,133,576	817,015	1,950,591	38,355	36,298	74,653
Rhode Island	76,963	54,550	131,513	2,744	2,735	5,479
South Carolina	409,000	210,600	619,600	12,585	8,305	20,890
South Dakota	115,200	38,000	153,200	5,860	2,420	8,280
Tennessee	636,800	187,200	824,000	19,881	7,500	27,381
Texas	1,657,540	472,427	2,129,967	54,930	26,480	81,410
Utah	145,939	97,832	243,771	4,500	3,700	8,200
Vermont	53,393	21,498	74,891	2,056	1,010	3,066
Virginia	625,000	254,500	879,500	19,300	11,800	31,100
Washington	406,630	238,270	644,900	14,310	9,790	24,100
West Virginia	282,000	175,000	457,000	9,230	6,190	15,420
Wisconsin	517,000	208,000	725,000	19,900	9,050	28,950
Wyoming	64,050	19,650	83,700	2,507	1,158	3,665
TOTAL	25,265,620	11,978,664	37,244,284	857,353	551,609	1,408,962

Source: Research Division, National Education Association of the United States. *Estimates of School Statistics, 1960-1961.* December 1960 (Research Report 1960-R15) pp. 21, 23.

	NUMBER OF STUDENTS			NUMBER OF TEACHERS
CANADA	Elementary Kindergarten - 8	Secondary 9 - 12	TOTAL	Elementary and Secondary Kindergarten - 12
Alberta	217,330	60,178	277,508	11,137
British Columbia	231,107	68,610*	299,717	11,450
Manitoba	144,500	32,300	176,800	7,100
New Brunswick	121,620	21,288*	142,908	5,572
Newfoundland	103,546	15,733	119,279	3,896
Northwest Territories	3,839	293	4,132	214
Nova Scotia	147,500	28,700	176,200	6,240
Ontario	1,057,207	262,018*	1,319,225	45,705
Prince Edward Island	20,069	3,947	24,016	901
Quebec	920,230	127,064	1,047,294	43,256
Saskatchewan	155,521	39,228	194,749	8,468
Yukon Territory	1,853	305	2,158	96
TOTAL	3,124,322	659,664	3,783,986	144,035

*Includes grade 13

Source: Education Division, Dominion Bureau of Statistics. *Preliminary Statistics of Education, 1959-1960.* June 1960 (Bulletin No. 7001-512) Figures are selected and totaled by province for publicly controlled schools, 1959-1960 school year.

programs. Since about 1940, the proportion of funds from states has increased, and the proportion from local property taxes has decreased.

Private and Parochial Education. Private groups and churches may establish and support their own schools under general regulations in each state. But private schools, including parochial and other non-public schools, are prohibited from receiving tax funds for their support. From 1945 to 1960, the number of children attending private elementary and secondary schools rose from about 10 per cent to more than 15 per cent of the total school enrollment. The Roman Catholic Church conducts about 90 per cent of the private schools in the United States. See PAROCHIAL SCHOOL.

Education in Canada

Public education in Canada is largely controlled by each of the 10 provinces, rather than by the federal government. As in the United States, the national government limits itself to aiding certain kinds of vocational, technical, and higher education; and to providing research and information about education. The federal government controls only schools in the territories.

Each province has a minister of education who is a member of the provincial cabinet. He directs the province's department of education. The department sets standards for teacher training, curricula, examinations, and school buildings. Inspectors supervise the work of the schools. These officials are employees of the provincial government and have duties similar to superintendents of schools in the United States. Each large community has a superintendent of schools who is appointed by the community board of education.

Local school systems are organized into districts or sections that have considerable authority under local boards of education. The people of each district elect these boards. The province of Quebec has a dual system of public schools, one Roman Catholic and one Protestant. The Protestant schools teach in English and the Roman Catholic schools in French. The Catholic board of education levies taxes on Roman Catholics to support the Catholic public schools, and the Protestant board collects taxes from Protestants for the Protestant institutions. Newfoundland has four religious public-school systems, conducted by the Roman Catholic Church, the Church of England, the United Church of Canada, and the Salvation Army. Ontario, Saskatchewan, and Alberta permit the use of tax money to support the public schools of minority religious groups. These schools are called *separate* schools.

Canadian public-school systems that use the English language organize their schools somewhat similarly to those in the United States. In Quebec, the French-language schools teach the Roman Catholic religion. About half the teachers in the schools are nuns or priests. Most schools in Canada are coeducational except in Quebec.

Education in Other Countries

The governments of most countries have much more control over education than does the U.S. government. Even where education is controlled largely by states or provinces, as in Germany, Australia, and Canada, the state or provincial governments regulate curricula, teaching methods, educational materials, and teachers more closely than in the United States.

Most European countries have compulsory-attendance laws for children up to 12 or 14 years of age. Elementary schools generally admit all children, as do those in the United States. But most children in these countries do not go on to high school and college. The children are usually divided into two groups at age 11 or 12. The more scholarly students continue on in academic secondary schools, while the others attend vocational, trade, agricultural, or technical institutions.

Only graduates of academic secondary schools may enroll in the universities. The graduates of vocational schools go directly into jobs or to higher technical schools. Most boys and girls leave school at the age of 12 to 14. In general, the children of wealthy families attend the academic schools and universities. Children of poorer families attend the vocational schools. Few countries have comprehensive public high schools or free state universities as are found in the United States and Canada.

In academic schools, the main subjects include the country's language, foreign languages, mathematics, science, and history. Little attention is given to the arts and music, social sciences, physical education, and extracurricular activities. Standards are usually high, and intellectual achievement is emphasized. Schools in most countries are more formal than in the United States. Discipline is stricter. Separate schools for boys and girls are common, especially in secondary schools. Many schools require students to wear uniforms, to march into and out of classes, and to be quiet while others are reciting.

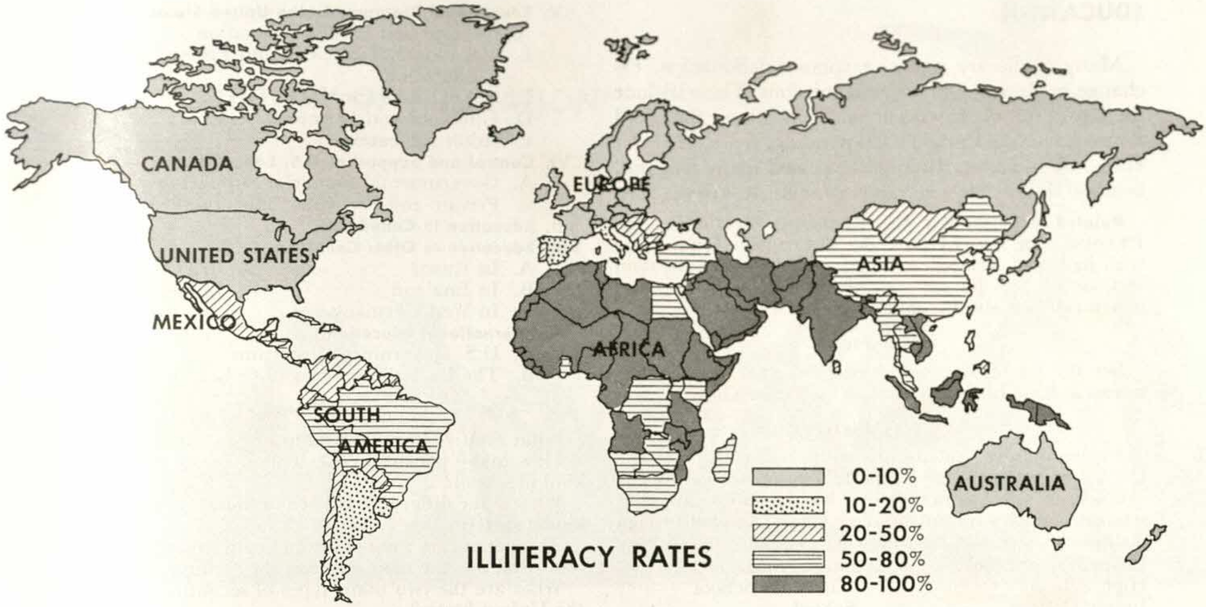
Most classroom activities consist of lecturing by teachers, copying by students in their notebooks, and memorizing and reciting. Students are required to pass certain examinations before they may advance from one grade to the next or from one school to the next. Comprehensive examinations are required for admission to and graduation from universities.

In every country with an official state religion, that religion is taught in both the public and the private schools. In Italy, Spain, and some countries of Latin America, schools teach Roman Catholicism. Lutheranism is taught in some Scandinavian countries, Islam in Egypt, and Judaism in Israel. In some countries, such as The Netherlands, England, and Canada, public funds aid the schools of several religious denominations. Religious schools were abolished in Communist Russia and in Nazi Germany.

The most pressing educational problems of underdeveloped countries include the high rate of illiteracy and the scarcity of school buildings, well-trained teachers, books, and materials.

In a dictatorship, children are not encouraged to become critical thinkers. Textbooks often present a distorted picture of the truth. The beliefs of the ruling group dominate the curriculum.

In Russia, schools are used to indoctrinate students with the principles and beliefs of communism. Education is free, and all children are required to attend school. Many Russian youngsters start school as early as 3 years of age. Only bright children continue through high school and go on to the universities. The Soviet



The Percentage of Persons Who Cannot Read or Write, or the *illiteracy rate*, varies throughout the world. The United States and Canada have less than 5 per cent illiterates. The countries of northern and western Europe, Japan, and Australia also have extremely low illiteracy rates. But in some parts of Africa and southeastern Asia, more than four fifths of the people cannot read or write. Almost half of all the adults living in the world at the present time cannot read or write.

curriculum places great emphasis on the study of science, mathematics, languages, and work experience.

In England, all children between the ages of 5 and 15 must attend school. There are two types of schools. The *county schools* are supported by local communities, with financial help from the national government. Private organizations support a large number of *voluntary schools*. The Ministry of Education has general supervision over all schools in England.

In West Germany, all children between the ages of 6 and 18 must attend school. After completing several grades in elementary school, the children are separated on the basis of academic ability. Students with high ability may go to high school and those with low academic ability may attend vocational school. In East Germany, the communists control all education.

In France, children between 6 and 14 must go to school. The government controls schools through the Ministry of Education. The Roman Catholic Church operates a large number of schools in France.

In South America, children are required to attend primary school. The national governments control education, and public elementary schools are free. Most secondary schools are privately operated. Even though education is required, many children do not attend, because of a lack of school buildings and trained teachers.

For information on the educational systems of specific nations, see the Education section of the various country articles, such as GERMANY (Education).

International Education

Good relationships among countries promote peace. International education seeks to improve understanding among peoples in several ways. Modern school programs give increasing attention to the study of the life, institutions, and customs of other nations. Many students and teachers travel and study in other countries, and students and teachers from other countries have come in increasing numbers to the United States and Canada. Special cooperative programs have been undertaken, in which one country helps another to improve its educational system. The United States has sent educational experts to study and help improve schools in such countries as India, Afghanistan, and Greece. Comparative education courses in colleges and universities describe the educational systems of other countries and compare them with Canadian and American programs.

U.S. Government Programs. Since World War II, the United States has established several programs to promote international understanding. For example, *Fulbright scholarships* provide American students and teachers with funds to study, teach, or conduct research in other countries (see FULBRIGHT SCHOLARSHIP). *Smith-Mundt fellowships* enable foreign students to travel and study in the United States. The *International Cooperation Administration*, an agency of the U.S. Department of State, sends teams of experts to underdeveloped countries at their request to help with educational and technical problems. The *U.S. Information Service* tries to explain American life and ideals to other peoples through radio programs, magazines, libraries, and exhibits.

The United Nations and Other Organizations. Most members of the United Nations try to understand each other and work together to promote international cooperation in education. The United Nations Educational, Scientific, and Cultural Organization (UNESCO) works to help underdeveloped countries improve their school systems, fight prejudice and illiteracy, and promote peace, international cooperation, and equal opportunities for education. This has been accomplished by programs such as international conferences and exchanges of teachers and students. See UNESCO.

Many voluntary agencies sponsor fellowships, exchange programs, and overseas missions. These include the Institute of International Education, the Ford Foundation, the Carnegie Corporation, the Rockefeller Foundation, Rotary International, and many religious, business, industrial, and labor groups. R. Freeman Butts

Related Articles. See the Education section of the Reading and Study Guide. See Education, History of with its list of Related Articles. See also the Education sections of articles on various countries, states, and provinces. See also the following articles:

Biographies

See the list of biographies of Educators in the Biography section of the Reading and Study Guide.

Educational Institutions

Regionally accredited universities and colleges in the United States are listed in the Education sections of the articles on the various states. World Book also has separate articles on outstanding Canadian and foreign institutions. See also the following articles:

Elementary School
High School
Junior College
Junior High School
Kindergarten
Nursery School
Parochial School
School
Universities and Colleges

Educational Programs

Adult Education
Agricultural Education
Art and the Arts
Business Education
Character Education
Handicapped, The
Handicraft
Human Relations
Humanities, The
Parent Education
Preschool Education
Religious Education
Science
Social Studies
Vocational Education

Organizations and Agencies

Adult Education
  Association of the U.S.A.
Education, Office of
Foundations
National Education
  Association of the U.S.
Parents and Teachers,
  National Congress of
Teachers, American
  Federation of
UNESCO

School Subjects

For a complete list of articles on school subjects, see the Education section of the Reading and Study Guide.

Unclassified

Audio-Visual Aids
Coeducation
Curriculum
Grading
Guidance
Illiteracy
Learning
Library
Museum
Pedagogy
Research
Student Government
Study
Teaching
Television (In Education)
Tests and Measurements

Outline

I. Purposes of Education
  A. Knowledge
  B. Intellectual Discipline
  C. Citizenship
  D. Individual Development
  E. Vocational Training
  F. Character
II. Various Views on Education
III. The Educative Process
  A. How People Learn
  B. How Teachers Guide Learning
IV. Educational Institutions in the United States
  A. Pre-Elementary Education
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  D. Higher Education
V. Educational Programs in the United States
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  B. Vocational, Technical, and Professional Education
  C. Special Education
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IX. International Education
  A. U.S. Government Programs
  B. The United Nations and Other Organizations

Questions

What are five important aims of education?

How many persons in the United States attend some kind of school?

What is the difference between a nursery school and a kindergarten?

At what age do most children begin "regular" school, and what are the main subjects they study?

What are the two main types of secondary schools in the United States?

What are five sources of adult education?

What unit of government in the United States has general authority over public education?

What group operates about 90 per cent of the private schools in the United States?

How does control of education in most countries differ from that in the United States?

What Canadian province has four religious public school systems?

Who is the chief school official in the provinces of Canada?

Books to Read

Bereday, George Z., and Volpicelli, Luigi, eds. *Public Education in America*. Harper, 1958.

Brubacher, John S., and Ruby, S. W. *Higher Education in Transition: An American History, 1636-1956*. Harper, 1958.

Butts, R. Freeman, and Cremin, Lawrence A. *A History of Education in American Culture*. Holt, 1953.

Caswell, Hollis L., and Foshay, A. W. *Education in the Elementary School*. 3rd ed. American Book Co., 1957. This book describes major problems, programs, and issues of elementary education.

Cremin, Lawrence A., and Borrowman, M. L. *Public Schools in Our Democracy*. Macmillan, 1956. A general description for high school students of the organization and importance of American public schools.

King, Edmund J. *Other Schools and Ours*. Rinehart, 1958. Education in many countries.

Stiles, Lindley J., ed. *The Teacher's Role in American Society*. Harper, 1957. A comprehensive examination of the American teacher's status and role.

Thayer, V. T. *The Role of the School in American Society*. Dodd, 1960. The purposes, function, organization, and issues of the American school system.

United States Office of Education. *Education in the United States of America*. U.S. G.P.O., 1960. A broad view of educational programs and their organization presented to acquaint readers with American schools.

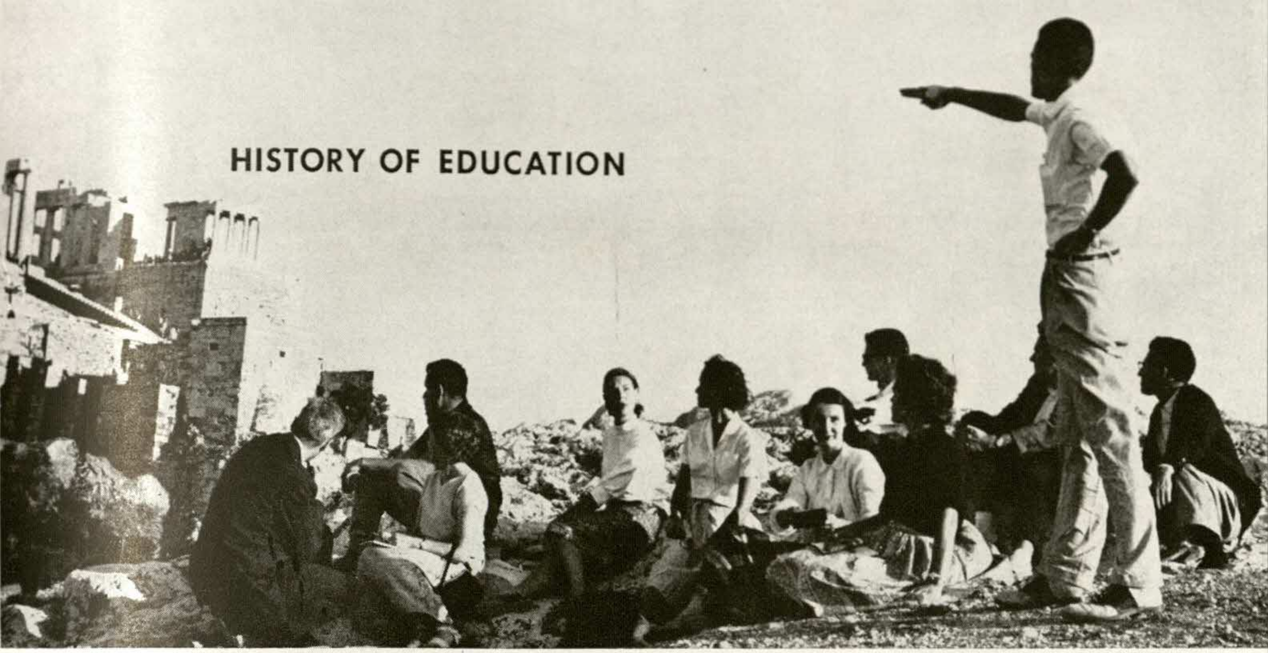
EDUCATION, ADULT. See Adult Education.

EDUCATION, AGRICULTURAL. See Agricultural Education.

EDUCATION, AMERICAN COUNCIL ON. See American Council on Education.

EDUCATION, BUSINESS. See Business Education.

HISTORY OF EDUCATION



Jean Mounicq, Magnum

Education Links the Past with the Present. Man's quest for knowledge has always been one of his chief activities. Here, students study the ancient Acropolis in Athens.

EDUCATION, HISTORY OF. Throughout history, education has always been one of man's most important activities. In fact, man could not carry on government, family life, religion, or earn a living, without some form of education. To understand human development and man himself, we need to understand the history of education.

In a democracy, education is everyone's business. We first become interested in education as learners and as students in school. Later, as citizens, we pay taxes and help run the public schools. The kind of education everyone receives is as important to each of us as is our own education. This is because the quality of a community or nation depends largely upon the kind of education all its citizens receive. A community of well-educated people makes a good place to live.

Our present methods of education have been influenced by the way education has developed. In order to understand and improve our present educational system, we need to know how education began and how it has changed through the years.

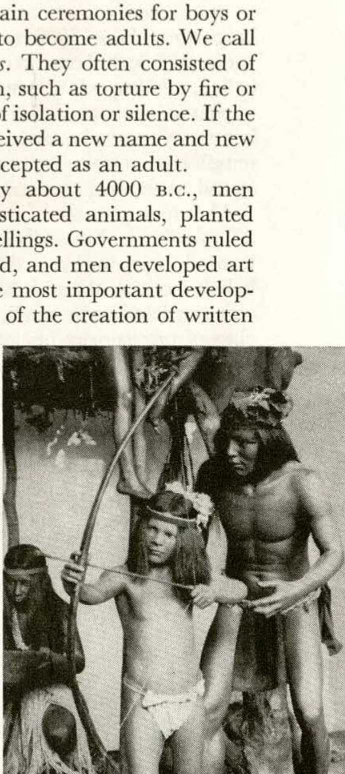
Education in Ancient Times

In Prehistoric Times. For thousands of years, primitive men lived in families and groups of related families called *tribes*. Early men had only simple tools. They lived in caves, trees, or huts. Parents or the elders in the tribe taught the children how to hunt, fish, fight, make clothes, and build dwellings with stone tools. See PREHISTORIC MAN.

Education was direct and simple. The children imitated what the adults did. Each tribe developed certain customs, beliefs, and ways of doing things. Education consisted of handing down these *folkways* from the elders to the young.

No schools or teachers in our sense of the word existed. Some of the elders were recognized as medicine men or priests. They conducted certain ceremonies for boys or girls when they were ready to become adults. We call these ceremonies *puberty rites*. They often consisted of tests of endurance or strength, such as torture by fire or whipping, and long periods of isolation or silence. If the youth passed the tests, he received a new name and new clothes, and was formally accepted as an adult.

In Early Civilizations. By about 4000 B.C., men improved their tools, domesticated animals, planted crops, and built sturdier dwellings. Governments ruled by kings and priests appeared, and men developed art and religious beliefs. But the most important development in education consisted of the creation of written



In Primitive Societies, education consists of teaching youngsters practical skills. In this museum model, an American Indian father teaches his son the way to use a bow and arrow. They are Cocopa Indians who lived in the Southwest.

U.S. National Museum

Education in Ancient Greece aimed at developing well-rounded citizens. This painting, *A Reading from Homer* by Sir Lawrence Alma-Tadema, shows pupils studying the epic poems of Homer. Greek students also learned music and dancing.

languages about 3000 B.C. in the Middle East and India. Men could now keep records of basic knowledge, beliefs, and important customs. When written languages appeared, the school as a special institution for educating the young also appeared. Priests in the religious temples or scribes connected with the kings' offices served as the first teachers.

The main purpose of these first schools was teaching a limited number of boys to read and write. They learned how to keep the records of laws, religious beliefs, contracts, and business transactions. Education was restricted to a small, privileged, and aristocratic class of priests or public officials. Girls did not usually go to school.

Ancient Egyptian schools concentrated on teaching the language and moral qualities contained in their religious literature, especially the *Book of the Dead*. The *Book of the Dead* described how the soul should act after death (see EGYPT, ANCIENT [Activities of the People]). In the schools of ancient India, boys learned the Sanskrit language and studied religious classics, such as the *Vedas* and *Puranas*, and epics, such as the *Mahabharata* and the *Ramayana* (see SANSKRIT LANGUAGE AND LITERATURE). Ancient Jewish schools centered about the first five books of the Bible, the Pentateuch, which they called the *Torah* (see PENTATEUCH). These books contained the law of Moses written in Hebrew. The main method of teaching consisted of memorizing long passages from the books. Discipline was strict in the Jewish schools, and whipping was the usual punishment given to students (see HEBREW LANGUAGE AND LITERATURE).

Outside of schools, children sometimes learned a trade by a system of direct apprenticeship to a master craftsman (see APPRENTICE). The master craftsman taught the child his trade on the job.

In Ancient Greece. During the 400's and 300's B.C., two great ideals dominated Greek education: (1) education for citizenship, and (2) education for well-rounded individual development. Education no longer belonged to a few members of a ruling or priestly class. The *polis*, or city-state, expected education of all citizens. As a result, education in Greece became a *political* (from the word *polis*) matter, rather than a family or tribal affair.

In democratic Athens, the ideal of the good citizen coincided with the ideal of well-rounded development. A youth of the citizen class went to a *grammar* school, where he learned to read, write, and count. He attended a *music* school, where he learned to sing, play a musical instrument, dance, and memorize such great epic poems as the *Iliad* of Homer. He also went to a *palaestra* and later to a *gymnasium*, where he developed his body through gymnastics. He learned to play such Greek games as the *pentathlon* (running, jumping, wrestling, and discus and javelin throwing). These games still exist in the Olympic Games of today (see OLYMPIC GAMES). The Athenian boy developed the intellectual, artistic, and physical abilities of a free man. He received a *liberal education*.

In nondemocratic Sparta, all education was designed to develop physical and warlike qualities needed by the citizens of a *military* state. Boys went to schools in public barracks and lived an army life. The intellectual, literary, or artistic side of life received little or no attention from the Spartans.

In contrast, Athens produced great teachers. Socrates taught small groups informally by discussion. Plato taught philosophy and mathematics in his Academy (see ACADEMY). Aristotle taught philosophy and science in his Lyceum (see LYCEUM). Isocrates taught *oratory*, or public speaking, in his rhetorical school. The great teachers were also the great philosophers and thinkers of the day. We still read the writings of Plato, Aristotle, and other Greek teachers.

During the 200's and 100's B.C., the Greek city-states lost their freedom to the Macedonians and the Romans. Greek education lost much of its well-rounded character. Education became almost entirely bookish and academic. It paid little attention to physical and artistic qualities, and belonged to a few persons in the aristocratic classes.

For the contributions of outstanding men during this period, see ARISTOTLE; EPICURUS; ISOCRATES; LYCURGUS; PLATO; SOCRATES; ZENO.

In Ancient Rome. From the 400's to 100's B.C., Roman families usually taught their children at home. As the Latin language developed and the Greek language came to Rome, private teachers established schools. The *ludus*, or elementary school, taught young children to read and write Latin. It copied the Greek grammar school. It did not emphasize physical, musical, or artistic abilities. The methods consisted of memorizing and physical punishment.

The *school of the grammaticus*, or the grammar school, became a secondary school. It carried on a child's education in grammar, composition, dictation, and memorizing sentences. The first Roman grammar schools copied Greek grammar schools and taught the Greek language. The Romans became the first people to stress the study of a foreign language. Later, Latin grammar schools carried on the study of the Romans' own language and literature. The main works of literature studied included Homer's *Iliad* and *Odyssey* and Virgil's *Aeneid*. The Romans also established higher schools for training orators and statesmen. Cicero and Quintilian became the outstanding spokesmen for this kind of rhetorical education.

From the A.D. 100's to 400's, Roman municipal governments began to aid schools and higher institutions. Then the private schools of earlier days began to give way to state schools.

The most lasting contribution of Roman education consisted of its emphasis on Latin grammar and literature, and the formulation of the *seven liberal arts*. These were the seven intellectual studies necessary for a free spirit: grammar, rhetoric, and logic made up the *trivium*, and arithmetic, geometry, astronomy, and music made up the *quadrivium*. For hundreds of years, the seven liberal arts were the main studies of a liberal education. See LIBERAL ARTS.

For the contributions of outstanding men during this period, see CICERO, MARCUS TULLIUS; EPICTETUS; QUINTILIAN.

European Education in the Middle Ages

Elementary and Secondary Schools. Christian schools appeared during the time of the Roman Empire. Some of these schools gave specific religious instruction to adults who were joining the church. Others resembled the philosophical schools of ancient Greece. Famous teachers included Clement in Alexandria, St. John Chrysostom in Antioch, and St. Justin the Martyr in Rome. When Emperor Justinian closed the pagan schools in Greece in A.D. 529, the church schools became the dominant schools of the Middle Ages.

From the 500's to the 1000's, civil authorities in the Italian towns continued to maintain schools. Kings and emperors, such as Alfred the Great and Charlemagne, supported schools. But priests in the parish churches and monks in the monasteries taught most of the schools. The main subjects in these schools were church music, and reading and writing Latin.

Outside of schools, the feudal courts taught upper-class young men the manners of chivalry and how to ride and fight on horseback. This education taught them to become knights. Lower-class youths learned a trade by apprenticeship to a master craftsman. The sons of farmers simply learned from their parents how to till the soil.

Higher Schools. From the 1000's to the 1200's, the monks and special teachers in the cathedrals conducted schools of higher education. The cathedral schools taught the seven liberal arts formulated during the Roman Empire. But the church interpreted the seven liberal arts according to its own doctrines. Outstanding

Monastery Schools of the Middle Ages served as the chief centers of education during that period. Monks used handwritten books to teach their students to read and write Latin. Latin and church music were the main subjects taught.

Bettmann Archive

teachers included Alcuin and Bede in England, and Peter Abelard, Bernard of Chartres, John of Salisbury, and William of Champeaux in France.

By the 1200's, the teachers in some of the cathedral schools had organized universities. They established a required *curriculum*, or course of study, and set the requirements for admission and degrees.

By 1500, Europe had nearly 80 universities. The outstanding universities in France were at Paris, Montpellier, and Toulouse; in Italy at Bologna, Salerno, Siena, Naples, Padua, and Rome; in England at Oxford and Cambridge; and in Spain at Salamanca and Seville. Leading philosophers and teachers included Peter Lombard and St. Thomas Aquinas. Arab and Jewish scholars, notably Averroës and Moses Maimonides, influenced many of the subjects taught in the universities.

Students lived in residential halls known as *colleges*. The tutors and masters in the English colleges eventually took over some of the teaching, as well as the discipline of students. The founders of the first American colleges copied the organization of the colleges at Cambridge and Oxford.

For the contributions of outstanding men during this period, see ALBERTUS MAGNUS, SAINT; AQUINAS, SAINT THOMAS; BACON, ROGER; BEDE; DUNS SCOTUS, JOHN; LOMBARD, PETER.

European Education from 1300 to 1900

Renaissance and Reformation. During the period from the 1400's to the 1500's, the main influences on education consisted of the classical humanism of the Renaissance and the religious spirit stimulated by the Protestant Reformation. See HUMANISM; REFORMATION; RENAISSANCE.

The Renaissance represented a renewed desire for the Greek ideal of well-rounded development in education. The humanists looked to the *human* experience of classical Greece and Rome, rather than to the *religious* experience of the church in the Middle Ages. A well-rounded scholar-statesman became the ideal man of the humanists.

The humanists' emphasis on the study of classical Greek and Latin as the mark of an educated gentleman made the most lasting influence on education. Since the Renaissance, the principal secondary schools of Europe have continued to stress classical studies. These kinds of schools include the *gymnasium* in Germany, the *lycée* and *collège* in France, and the *grammar school* in Great Britain.

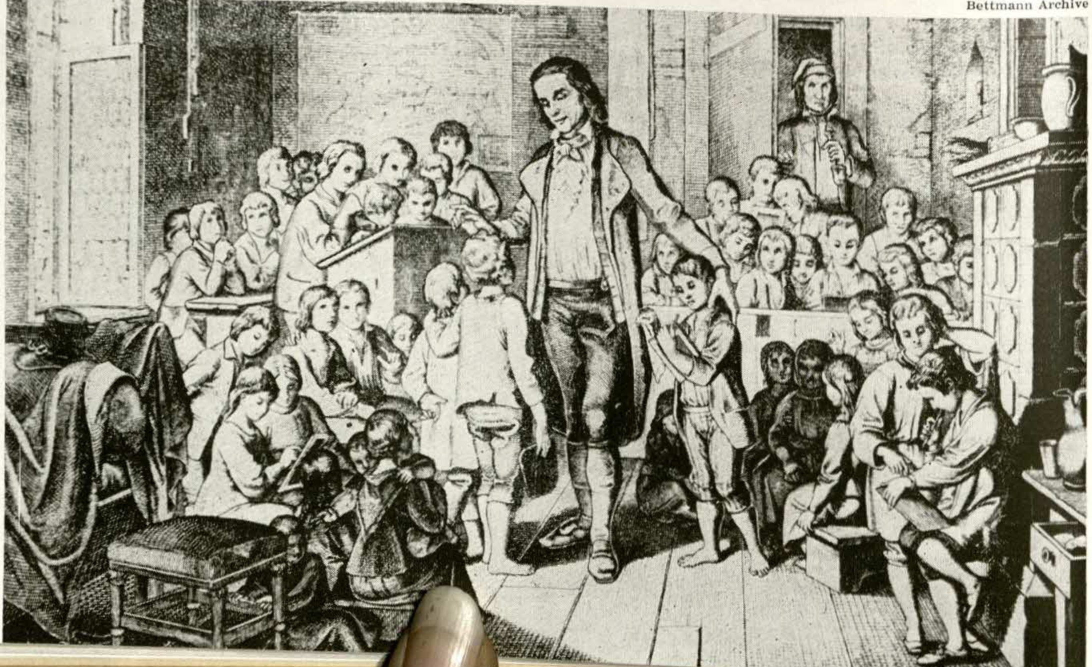
The Protestant reformers—Martin Luther, John Calvin, and John Knox—and their followers adopted the classical course of studies for secondary schools. But they insisted on elementary schools taught in the local language for the poorer classes. Different religious groups and the cities and rulers of northern Europe established many of these schools.

The Roman Catholic Church redoubled its educational efforts in order to offset the gains made in Protestant countries. Several new teaching orders established schools. These teaching orders included the Society of Jesus, the Port Royalists, the Fathers of the Oratory, and the Brothers of the Christian Schools. The Ursuline Sisters established schools to promote the special education of girls.

For contributions to education during this period, see ERASMUS, DESIDERIUS; JEAN BAPTISTE DE LA SALLE, SAINT; JESUIT; LOYOLA, SAINT IGNATIUS.

Scientific Revolution and the Age of Reason. During the 1600's and 1700's, the two most important influences on education consisted of the revolution in science and the doctrines of liberty and natural rights produced by the Age of Reason. See AGE OF REASON; RATIONALISM; SCIENCE (History).

During this period, classical and religious ideals remained strong in secondary schools. But the tremendous scientific discoveries and theories revolutionized man's conception of the universe and the world around him.



Johann Heinrich Pestalozzi teaches a class in one of the school-orphanages which he founded in Switzerland. This Swiss reformer, who died in 1827, greatly influenced the growth of modern and more democratic methods in education.

Bettmann Archive

Such men as Nicolaus Copernicus (1473-1543), Galileo (1564-1642), Johannes Kepler (1571-1630), William Harvey (1578-1657), and Sir Isaac Newton (1642-1727) developed scientific laws of nature. So educators argued that the study of science and mathematics should have a larger place in secondary education.

For younger children, educators proposed that learning should make greater use of pictures, models, play activities, and the real objects of nature, such as collections of stones and shells, or pet animals. These methods helped the child understand real things as well as words. Educators also argued that methods of teaching should rely more on arousing the interests of the child, rather than on strict discipline and corporal punishment. Leading advocates of *realism* and *naturalism* for learners included the Moravian bishop John Amos Comenius (1592-1670), and the philosophers John Locke (1632-1704) and Jean Jacques Rousseau (1712-1778).

Teachers and students at Halle and Göttingen in Germany pioneered in achieving the liberal ideal of academic freedom in universities.

For the contributions of outstanding men during this period, see BACON, FRANCIS; COMENIUS, JOHN AMOS; DIDEROT, DENIS; LOCKE, JOHN; MILTON, JOHN; ROUSSEAU, JEAN JACQUES.

The 1800's brought a spirit of nationalism that shaped the outstanding characteristics of education in most European countries (see NATIONALISM). This took the form of highly centralized systems of education controlled by national or central governments. Except in Great Britain, local authorities had little control over education. Governments established elementary schools for the poorer classes so they could be taught to be obedient, patriotic citizens.

In France, Napoleon established a national system of secondary schools. François Guizot, a member of the French cabinet from 1830 to 1848, promoted a centralized system of elementary schools. All French schools taught the same subjects in the same grade. Under the empire and the monarchy, French education favored the Roman Catholic Church and religious instruction. Under the republics, French public schools became separate from the church and concentrated on nonreligious subjects.

In Germany, the several German states—some chiefly Lutheran and some chiefly Roman Catholic—centralized the schools. Under the Prussian kings and German emperors, the common schools emphasized military obedience, strict discipline, and religious instruction. But many German universities became world-wide centers of research and scholarship. Outstanding educators during this period included Johann Heinrich Pestalozzi (1746-1827) of Switzerland and Friedrich Froebel (1782-1852) and Johann Friedrich Herbart (1776-1841), both of Germany.

In Great Britain, churches and charitable societies promoted schools more extensively than the government did. Robert Raikes originated the Sunday school in 1763. Robert Owen helped establish *infant schools*, or nurseries, after 1799 (see NURSERY SCHOOL). Andrew Bell and Joseph Lancaster developed *monitorial schools*, in which the students helped with the teaching. The most influential schools were "public" schools, such as Eton, Harrow, and Rugby. These schools, which Americans would call private, stressed a classical course of studies, good sportsmanship, and character training for upper-class boys.

For the contributions of outstanding persons during this period, see BINET, ALFRED; BRAILLE, LOUIS; FICHTE, JOHANN GOTTLIEB; HERBART, JOHANN FRIEDRICH; HUXLEY (Thomas Henry); JAHN, FRIEDRICH LUDWIG; MONTESSORI, MARIA; PESTALOZZI, JOHANN HEINRICH.

Education in the United States

Colonial Days. When the colonists came to America, they set up the kind of schools they had known in Europe. But they also had to adapt themselves to new and strange conditions.

During the 1600's, the New England colonists relied much more heavily upon their governments to provide schools than had been the case in England. Town meetings voted to establish town schools, and the colonial legislatures passed laws requiring towns to provide schools. The Massachusetts laws of 1642 and 1647 set the pattern. The law of 1642 became the first law in the English-speaking world to order that children should be taught to read. The law of 1647 required every town of over 50 families to establish an elementary school, and every town of 100 families to have a Latin grammar school. In the Southern and Middle colonies, private and religious groups more often established schools. But the colonial governments had general authority over schools.

Elementary schools taught reading, writing, arithmetic, and religion. The *New England Primer*, first published in 1690, became the most famous textbook. Much memorizing and whipping made up the main methods of teaching. Most children who attended school went for only two or three years. About 90 of every 100 children attended no school at all. Latin grammar schools offered secondary education to well-to-do boys, and poor children became apprentices to learn a trade.

The colonists created new kinds of schools in the 1700's, to give children a more practical education and to prepare them for jobs in business, trade, navigation, surveying, and other fields. The *academy* founded in Philadelphia by Benjamin Franklin in 1751 typified these new schools. The academies soon became more popular than the Latin grammar schools.

In 1636, Massachusetts founded Harvard College in Cambridge, Mass., to teach the liberal arts. By the time of the Revolutionary War, eight more colleges had been established: William and Mary, Yale, Princeton, Columbia, Pennsylvania, Brown, Rutgers, and Dartmouth. See COLONIAL LIFE IN AMERICA (Education); FRANKLIN, BENJAMIN; MATHER (family).

Growth of Public Schools. Following the Revolutionary War, many Americans realized that separate private and religious schools could not provide the equality, unity, and freedom necessary for the new democratic nation. Beginning in the 1830's, they organized state systems of public schools that would be open equally and freely to all.

To make the schools genuinely free, the states levied taxes upon everyone for their support. To make the schools equally good, the states set up state-wide requirements for taxation, attendance, courses of study,

Historical Pictures Service

Benjamin Franklin's Academy, founded in Philadelphia in 1751, was one of several colonial academies. They emphasized practical education to prepare students for jobs. Franklin's academy developed into the University of Pennsylvania.

RED-LETTER DATES IN AMERICAN EDUCATION

1633 The Dutch opened the first public school in the colonies at Nieuw Amsterdam (New York City).
1635 The Boston Latin School, one of the oldest public schools in the United States, began classes.
1636 Massachusetts chartered Harvard College, the oldest college in the United States.
1642 A Massachusetts law became the first in the English-speaking world to order that children should be taught to read.
1647 A Massachusetts law required every town of over 50 families to establish an elementary school, and every town of 100 families to have a Latin grammar school.
1785 Georgia chartered the first state university.
1795 The University of North Carolina became the first state university to hold classes.
1819 In the Dartmouth College Case, the Supreme Court protected private colleges from being taken over by the states.
1833 Oberlin Collegiate Institute became the first coeducational college in the United States.
1837 The first state board of education took office in Massachusetts, with Horace Mann as secretary.
1852 Massachusetts passed the first compulsory school-attendance law.
1862 The Morrill Act gave federal land to support state agricultural and mechanical colleges.
1874 In the Kalamazoo Case, the Michigan supreme court ruled that taxes could be collected to support public high schools.
1902 Joliet (Ill.) Junior College became the first public junior college in the United States.
1909 Berkeley (Calif.) opened the first junior high school in the United States.
1925 In the Oregon Case, the Supreme Court held that no state can require all children to attend public schools.
1954 The Supreme Court ruled that public schools segregated according to race are inherently unequal and therefore unconstitutional.
1958 Congress passed the National Defense Education Act designed chiefly to promote science, mathematics, and foreign-language instruction.

and preparation of teachers. To preserve the religious freedom of all, the states did not allow special religious instruction in the public schools. Outstanding leaders in founding the public school systems included Horace Mann (1796-1859) of Massachusetts and Henry Barnard (1811-1900) of Connecticut.

The United States soon developed the *ladder system* of education. Older boys and girls who had finished elementary school could go to public high schools. State universities completed the public system at the top. A boy or girl could go as far up the educational ladder as his talents would take him. The first public high school opened in 1821 in Boston. The Kalamazoo Case in Michigan in 1874 held that general taxes could be levied for the support of public high schools, as well as for elementary schools and state universities. By 1900, public high schools had become more popular than private academies.

In the Dartmouth College Case of 1819, the Supreme Court protected the rights of private colleges from undue state control. The Morrill Act, passed by Congress in 1862, gave large amounts of federal land for the support of state agricultural and mechanical colleges (see LAND-GRANT COLLEGE OR UNIVERSITY). But several bills for general aid to public schools failed to pass Congress in the 1870's and 1880's.

For the contributions of outstanding persons during this period, see BARNARD, HENRY; HARPER, WILLIAM RAINEY; JEFFERSON, THOMAS (University Founder); LYON, MARY; MANN, HORACE; WASHINGTON, BOOKER T.; WILLARD, EMMA HART.

Expanding Courses of Study. During the 1800's, all educational institutions added many new kinds of subjects to their courses of study. Elementary schools taught not only reading, writing, and arithmetic. They also taught art, bookkeeping, drawing, geography, history, homemaking, manual training, music, nature study, physical education, and science.

In high schools, dozens of new academic subjects, including English, modern languages, social science, and science, competed with the older studies of Latin, Greek, and mathematics. Vocational, technical, and practical studies in shops and laboratories became available. So the high schools usually became *comprehensive schools*, in which the same school offered several kinds of courses.

In colleges, so many new courses appeared in the courses of study that students could no longer take them all. Universities and colleges adopted the *elective system* to permit students to choose among the many courses that they offered.

Teaching methods began to give more attention to the interests and needs of children. The new methods emphasized *active* rather than *passive* learning. For example, they stressed the study of things as well as books, and thinking rather than merely memorizing. The new methods depended on group discipline rather than physical punishment. Margaretha Schurz, the wife of Carl Schurz, opened the first private kindergarten in Watertown, Wis., in 1855 (see Kindergarten). The public-school system of St. Louis adopted the kindergarten idea in 1873. Outstanding spokesmen for "modernizing" education included William T. Harris (1853-1908) in St. Louis; Francis W. Parker (1837-1902) in Quincy, Mass.; G. Stanley Hall (1844-1924) at Clark University in Worcester, Mass.; and John Dewey (1859-1952), who taught at the University of Chicago and at Columbia University.

For the contributions of outstanding persons during this period, see Dewey, John; Eliot, Charles William; Hall, Granville Stanley; Harris, William T.; Hopkins, Mark; James, William; McGuffey, William Holmes; Parker, Francis Wayland; Schurz (family).

Preparing Teachers. To prepare teachers for the newer kind of education in the public schools, special two-year institutions called *normal schools* appeared as early as the 1820's. These later became four-year teachers colleges and granted degrees. Liberal-arts colleges also trained teachers, but usually without much attention to teaching methods or professional preparation. To insure that teachers were well-prepared, the states issued *certificates*, or licenses, to qualified persons. These certificates usually required professional courses in the history and philosophy of education, psychology of learning, principles of teaching, and practice-teaching. They also required advanced training in the teacher's special field of study.

Many universities began to offer advanced professional education leading to master's and doctor's degrees. Teachers College at Columbia University became an early leader in this field. Basic educational research helped produce a body of systematic knowledge upon which the teaching profession could rely. Leaders in educational psychology included Edward L. Thorndike (1874-1949) at Teachers College, Charles H. Judd (1873-1946) at the University of Chicago, and Lewis M. Terman (1877-1956) at Stanford University. Paul Monroe (1869-1947) at Teachers College and Ellwood P. Cubberley (1868-1941) at Stanford University were leaders in the history of education.

For the contributions of outstanding men during this period, see Butler, Nicholas Murray; Cubberley, Ellwood P.; Gilman, Daniel Coit; Judd, Charles H.; Thorndike, Edward L.

Recent Developments include increased activity by the federal government in many aspects of education in the United States. For example, the Servicemen's Readjustment Act of 1944, usually called the G.I. Bill of Rights, granted federal funds to veterans of World War II to attend schools and colleges (see G.I. Bill of Rights). The Fulbright Act of 1946 provided money to help American students, teachers, and scholars to travel for study in other countries. It also helped students from other countries to study in the United States (see Fulbright Scholarship). In 1953, the Department of Health, Education, and Welfare was established with a secretary in the President's Cabinet. This department includes the federal Office of Education, first organized in 1867 (see Education, Office of). In 1954, the Supreme Court ruled that states cannot require Negro children to attend public schools that are segregated on the basis of race.

The great philanthropic foundations have become another new force in American education. For example, the General Education Board, a Rockefeller foundation, used a fund of $130,000,000 to raise educational standards in the southern United States. In 1955, the Ford Foundation and the Carnegie Corporation of New York established the National Merit Scholarship Corporation. On the basis of achievement in nationwide examinations, this foundation awards college scholarships to selected high-school graduates. See Foundations (Education).

In 1958, Congress passed the National Defense Education Act. This bill provided funds to promote science, mathematics, and foreign-language instruction. The act also aimed to improve testing, guidance, and counseling; to extend audio-visual techniques; to broaden vocational education; and to finance fellowships and loans for needy college students.

For a discussion of the present system of education in the United States, see Education.

Education in Canada

From the early 1600's to the middle 1700's, most of Canada's settlers were French Roman Catholics. The teaching orders and clergy of the Roman Catholic Church controlled most schooling, and taught in the French language. After the Treaty of Paris in 1763, Canada came under control of Great Britain. Most Canadian settlers were English Protestants after this time. The Protestants became a majority in all the provinces except Quebec. They established a variety of private schools based on the religion of the Church of England or of other Protestant groups. These schools taught in the English language.

After 1800, the English made attempts in Quebec to set up a common school system for both French Roman Catholics and English Protestants. These attempts failed because of the opposition of the Roman Catholic Church. In 1846, a law authorized one school system for French Roman Catholics and a separate system for English Protestants. The province of Ontario, where Protestants outnumbered Roman Catholics, had a similar arrangement.

In 1867, the British North America Act brought about federation of all the Canadian provinces. It left education in the hands of the provinces. But it provided that minority rights in education that were in effect before 1867 could not be changed after federation. So 5 of Canada's 10 provinces—Quebec, Ontario, Newfoundland, Alberta, and Saskatchewan—set up dual, or *separate*, school systems based on differences in religion and language. See CANADA (Education).

Education in Latin America

Before the conquest of Latin America by Europeans in the 1500's, education among the many Indian tribes resembled that of primitive peoples and early civilizations in Asia and Europe. It stressed apprenticeship and direct, informal teaching in families.

From the 1500's to the 1800's, Spain and Portugal ruled colonial empires in Latin America. The teaching orders of the Roman Catholic Church—Jesuits, Franciscans, Dominicans, and Augustinians—established schools. They devoted much effort to organizing mission schools to convert the Indians to Christianity, and religious seminaries to train church leaders. Schools emphasized the humanistic and classical subjects similar to those taught during the Renaissance in schools in Spain and Portugal.

Colleges and universities appeared early in colonial Latin America. The first university in the Western Hemisphere was established in Santo Domingo (now the Dominican Republic) in 1538, nearly a hundred years before Harvard College in Massachusetts.

After Latin America won its independence from Spain and Portugal, the power of the Roman Catholic Church in education declined. Latin-American governments made some efforts to establish government schools and to extend educational opportunity to the people. Poverty and the lack of professionally trained teachers and administrators have slowed achievement in many areas. But Argentina, Chile, Colombia, Costa Rica, Mexico, and Uruguay have made rapid advances in the 1900's. See LATIN AMERICA (Education).

Education in Asia, Africa, and Oceania

Civilizations in China, Japan, India, and the Middle East are more ancient than European civilization. From 100 B.C. onward, education in China emphasized the literature of the great philosophers Confucius and Lao-tse (see CONFUCIUS; LAO-TSE). It concentrated on the reading and writing of *Mandarin*, the Chinese language of scholarship, and centered in the temples of priests and offices of rulers. The state used a rigid system of examinations to select boys who could become scholars and officials of the aristocratic classes.

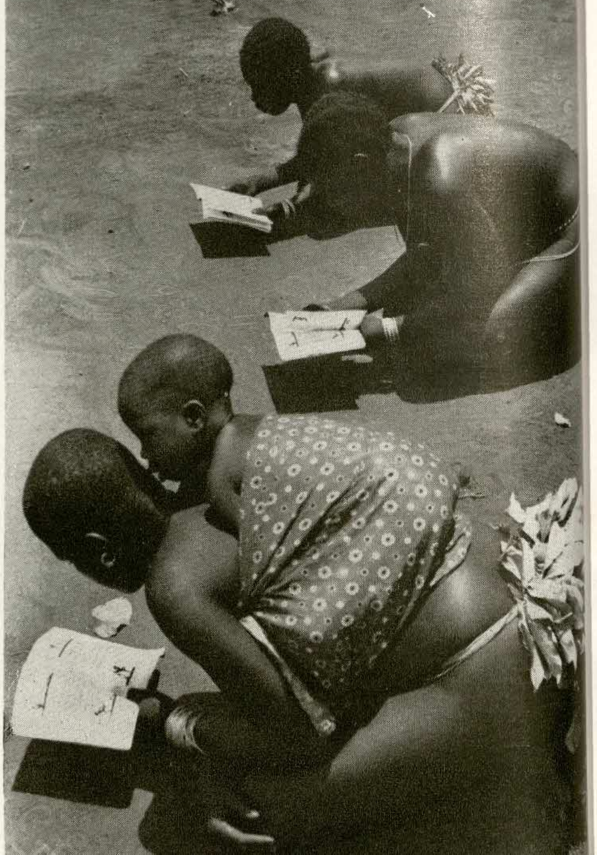
Japanese culture, language, and education borrowed heavily from the Chinese. When Japan opened its doors to Western influence in the late 1800's, the government set up a centralized system of schools modeled somewhat on the French school system.

About 2000 B.C., the Aryan peoples of central Asia began a series of invasions of India (see ARYAN). From that time, their Sanskrit language and Hindu religion played a strong part in Indian education. Indians made great contributions to religion, philosophy, mathematics, and art. They designed education mainly for religious purposes through literary teaching of upper-caste boys (see CASTE). This education had become fairly widespread by the 1600's. After the British conquered India in 1857, they established English schools to train middle-class Indians for the civil service. But the British made relatively little education available for the masses of people. After India and Pakistan gained independence in 1947, both countries made great efforts to develop a common education for all. Ceylon, which has been independent since 1948, has followed a similar program.

From the 1600's onward, European explorations, trade, conquests, and missionary efforts have carried Western influence around the world. British influence extended not only to India, but also to Africa, Australia, China, the Middle East, and New Zealand. The Union of South Africa has a mixture of British, Dutch, and Native culture with a separate education for each people. French influence has been strong in many countries of the Middle East and North Africa. These countries often have centralized schools and universities, and put a powerful scholarly emphasis on Islamic literature and religion. English and Scottish influence has been strong in Australia and New Zealand. In Australia, private secondary schools were more important than public schools until well into the 1900's. The Dutch controlled Indonesia until after World War II. They introduced Dutch education to the upper classes

Education in Africa is brought up to date with modern textbooks. In this Sudanese *bush school*, young and old alike learn to read. Such schools represent a great step forward in bringing African education into tune with present-day life.

George Rodger, Magnum



of Indonesians. In the Philippines, American influence replaced Spanish influence after 1898.

Asian and African peoples who have won freedom since World War II face tremendous problems of education. They must develop literacy, and train men to aid in the change from an agricultural to an industrial life. They must also learn to govern themselves. Education must play its part in these tasks. R. Freeman Butts

Related Articles. See the Education section of the Reading and Study Guide for lists of World Book articles which refer to the history of education. For the history of education in countries, states, and provinces, see the Education sections in these articles, such as Canada (Education). See also the following articles:

Biographies

See the list of Educators in the Biography section of the Reading and Study Guide. See also the separate biographies of outstanding educators mentioned in the various sections of this article.

Institutions

Academy
Conservatory
Elementary School
High School
Junior College
Junior High School
Kindergarten
Land-Grant College or University
Library
Lyceum
Museum
Night School
Nursery School
Parochial School
Platoon School
Preparatory School
School
Universities and Colleges

Unclassified

Academic Freedom
Adult Education
Coeducation
Curriculum
Degree, College
Education
Illiteracy
Learning
Smith-Hughes Act
Teaching
Vocational Education

Outline

I. Education in Ancient Times
  A. In Prehistoric Times
  B. In Early Civilizations
  C. In Ancient Greece
  D. In Ancient Rome
II. Education in the Middle Ages
  A. Elementary and Secondary Schools
  B. Higher Schools
III. European Education from 1300 to 1900
  A. Renaissance and Reformation
  B. Scientific Revolution and the Age of Reason
  C. The 1800's
IV. Education in the United States
  A. Colonial Days
  B. Growth of Public Schools
  C. Expanding Courses of Study
  D. Preparing Teachers
  E. Recent Developments
V. Education in Canada
VI. Education in Latin America
VII. Education in Asia, Africa, and Oceania

Questions

In what way did prehistoric peoples educate their children?

What were two ideals for education in ancient Greece?

What were the seven liberal arts studied in Roman times and the Middle Ages?

How did the cathedral schools contribute to the development of education in Europe?

What new emphasis did Protestant educators give to schools during the Reformation?

What developments took place in European schools during the 1600's and 1700's?

What subjects and teaching methods were used in colonial American schools?

How has the United States government aided the growth of colleges and universities?

How did French and British traditions influence the development of education in Canada?

EDUCATION, OFFICE OF, is an agency of the United States Government which acts as a clearinghouse for information on educational subjects. Specialists associated with the Office of Education collect statistics on schools and school systems. They make surveys and reports on educational problems and practices, and serve as advisers to educational organizations and committees, as well as to officials of schools and colleges. Specialists gather information for teachers, school administrators, and others. These facts are published in the agency's periodicals, *School Life, Higher Education,* and other printed aids.

The Office of Education distributes federal funds for vocational education, and for the maintenance of colleges of agriculture and the mechanic arts in the United States and Puerto Rico. It also handles funds for assistance to schools in "federally-affected areas," and for the School Facilities Survey Program.

The United States Bureau of Education, established by Congress in 1867, became an office in the Department of the Interior in 1869. It was transferred in 1939 to the Federal Security Agency. This agency, including the Office of Education, became the Department of Health, Education, and Welfare in 1953. The office is headed by a Commissioner of Education appointed by the President with the consent of the Senate. It is located in Washington, D.C. John C. Bollens

EDUCATION, SOCIETY FOR THE ADVANCEMENT OF. See Society for the Advancement of Education, Inc.

EDUCATION, VOCATIONAL. See Vocational Education.

EDUCATION ASSOCIATION, NATIONAL. See National Education Association of the United States.

EDUCATION ASSOCIATION, PROGRESSIVE. See Progressive Education Association.

EDUCATION OF THE HANDICAPPED. See Handicapped, The.

EDUCATION WEEK, AMERICAN, held each year in November, acquaints the public with the work of education, and with the problems of training children for effective citizenship. Education Week resulted from a meeting in 1921 of representatives of education and the American Legion. It has developed largely through promotion by the National Education Association and the United States Office of Education. Other countries have adopted the custom under the leadership of the World Federation of Education Associations. A typical Education Week program opens with sermons on education in the churches of the community. The rest of the week is devoted to such activities as special radio and television programs on school and community relations, special PTA meetings, and library and museum exhibits. Each year, a theme is announced for the observance of Education Week, with specific themes as topics for daily discussion. Themes have included "Good Schools Are Your Responsibility" and "Schools—Your Investment in America." Carter Alexander

EDUCATIONAL FOUNDATIONS AND ENDOWMENTS. See Foundations.

EDUCATIONAL GUIDANCE. See Guidance.

EDUCATIONAL MEASUREMENTS. See Tests and Measurements.

Edwards of England

GREAT SEAL OF EDWARD I

Culver

Edward I

Brown Bros.

Edward II

EDWARD was the name of eight different kings who ruled England.

Edward I (1239-1307) was named for Edward the Confessor. He is known as "The English Justinian" because of his fame as a lawgiver. A member of the royal family of Anjou, or Plantagenet, he succeeded his father, Henry III, in 1272 (see PLANTAGENET). He started a war against the Welsh in 1277, and finally subdued them in 1283. Wales then became part of the English realm.

Edward I devoted most of his reign to conquering Scotland. In 1290, of the several men who claimed the Scottish throne, Edward chose John de Baliol. But he insisted that Baliol pay homage to him. The Scottish people were humiliated by this demand, and revolted. In 1296, Baliol joined the rebel forces, but Edward forced him to surrender. The English king carried back to London the great Stone of Scone, the coronation stone upon which Scottish kings had been crowned for hundreds of years. Later in the year, the Scots, led by William Wallace, again rebelled (see WALLACE, SIR WILLIAM). Edward defeated them in 1298, but the Scots were not pacified. After a long struggle, Robert Bruce was crowned King of Scotland in 1306 (see BRUCE, ROBERT). Edward died on his way to subdue the new king.

Edward's Scottish policy delayed the union of the two kingdoms for 400 years. He also did little to improve relations with France. But his need for money to supply his army and government led him to call a parliament that would represent the entire country. In 1295, the new parliament met. It consisted of representatives of the nobility, the church, and the common people. This system of representation set a model for later parliaments (see MODEL PARLIAMENT). Edward restricted the power of the king by accepting the rule that taxes could be levied and laws made only with the consent of parliament. He also sponsored laws aimed at destroying the feudal system, and at limiting the power of the church. Edward married Eleanor of Castile and, after her death, Margaret, the sister of King Philip IV of France.

Edward II (1284-1327) succeeded his father, Edward I, in 1307. He had become the first English Prince of Wales in 1301 (see PRINCE OF WALES). Edward was an incompetent ruler. His failure to subdue the Scots at Bannockburn in 1314 assured Scottish independence (see BANNOCKBURN, BATTLE OF). Finally, parliament forced him to give up the throne in 1327. He was murdered soon after. The murder is dramatically described in Christopher Marlowe's play, *Edward II*.

Edward III (1312-1377) was the son and successor of Edward II. In 1327, he invaded Scotland. But even though he won victories there, he could not crush the Scottish spirit of independence.

The English won the battle of Crécy in 1346, the first major battle of the Hundred Years' War with France. Edward III was assisted in this battle, as well as in the siege of Calais (1347), by his son Edward, the Black Prince, a courageous youth of 16 (see EDWARD, The Black Prince). But by 1375 the king was forced to withdraw from the struggle. He had lost most of his French possessions, and England was exhausted (see HUNDRED YEARS' WAR). During the last years of his reign, Edward quarreled constantly with parliament, whose members had the support of the Black Prince.

Edward IV (1442-1483), son of Richard, Duke of York, became king in 1461, when the houses of York and Lancaster were fighting the Wars of the Roses (see WARS OF THE ROSES). As leader of the Yorkists, he defeated his opponents at Towton in 1461, and won the crown from Henry VI of the house of Lancaster. But in 1469 the powerful Earl of Warwick shifted his support to the house of Lancaster, and Edward fled to Holland (see WARWICK, EARL OF). Two years later, he returned with an army and restored the house of York to the throne. He strengthened the royal power and paved the way for the absolute monarchy of the Tudors.

Edward V

Brown Bros.

Edward V (1470-1483), of the house of York, succeeded his father, Edward IV, at the age of 13. Richard, Duke of Gloucester, uncle of the young king, imprisoned Edward and his younger brother, the Duke of York, in the Tower of London. There, they were smothered to death by one of Richard's nobles. Richard then assumed the crown as Richard III. The mur-

Culver

Edward III

Brown Bros.

Edward IV

der in the Tower is one of the incidents in William Shakespeare's great historical tragedy, *Richard III* (see SHAKESPEARE, WILLIAM [Synopses of Plays]).

Edward VI (1537-1553), of the House of Tudor, was the son of Henry VIII by his third wife, Jane Seymour (see TUDOR, HOUSE OF). Edward succeeded his father as King of England and Ireland in 1547. During most of his short reign, the affairs of the kingdom were controlled by his uncle, Edward Seymour, Duke of Somerset. Protestantism was established as the state religion. The first Book of Common Prayer (1549), by Archbishop Thomas Cranmer, and what became the Thirty-nine Articles of Religion, were published (see THIRTY-NINE ARTICLES).

Edward VII (1841-1910), of the house of Saxe-Coburg, became King of Great Britain and Ireland in 1901. He was the oldest son of Queen Victoria and Prince Albert, and was made Prince of Wales. He studied at Edinburgh, Oxford, and Cambridge universities, and traveled extensively. In 1863, he married Princess Alexandra (1844-1925), daughter of King Christian IX of Denmark.

During Queen Victoria's widowhood, Edward represented her at public gatherings (see VICTORIA). He was a patron of the arts and sciences, and helped found the Royal College of Music. He was also one of England's leading sportsmen. Horses from his stables won the English Derby three times.

Edward was greatly interested in international affairs. On a visit to India in 1875 and 1876, he improved relations between his own country and the princes of India. His official visits to Ireland in 1885 and 1903 helped postpone a conflict that had seemed inevitable for centuries. He became the first reigning British monarch to visit Russia, and his presence there in 1908 strengthened the Anglo-Russian agreement of 1907. His son, George Frederick, who became King George V, succeeded him in 1910.

Edward VIII (1894-   ), of the house of Windsor, was the oldest son of King George V and Queen Mary of Great Britain (see WINDSOR). He became king upon his father's death on Jan. 20, 1936.

Edward was made Prince of Wales in 1911 at Caernarvon Castle, Wales. He was the first Prince of Wales in history to deliver his address in Welsh. He was educated at the Royal Naval College and at Oxford University. He served in World War I as aide-de-camp to Sir John French, one of England's most famous soldiers. The Prince became a great traveler, and was often called "The empire's salesman." After World War I, he made several trips to Canada, the United States, South America, Africa, India, Australia, and New Zealand, in the interests of world peace and British trade. His democratic spirit, charm, and diplomacy made him popular. As king, Edward showed a deep interest in the welfare of his people, especially the underprivileged and working classes.

Edward fell in love with Wallis Warfield Simpson (1896-   ), an American divorcee. Because his government was opposed to accepting her as queen, Edward abdicated his throne on Dec. 11, 1936. His brother, George VI, who succeeded him, gave him the title Duke of Windsor. The duke and Mrs. Simpson were married in June, 1937.

Edward served as governor of the Bahama Islands from 1940 to 1945, and tried to improve economic conditions there. After leaving the Bahamas, he visited England for the first time after his abdication. One of Elizabeth II's first acts was to welcome him back to the inner circle of the royal family. WILLARD M. WALLACE

EDWARD (1330-1376), known as THE BLACK PRINCE, is one of the most famous warriors in English history. He was the oldest son of King Edward III, and the father of King Richard II. He wore black armor at the battle of Crécy. Though only 16 at the time, he commanded a wing of his father's army in this first great battle of the Hundred Years' War. Ten years later, at Poitiers, he defeated a French army and captured the French king. See also CRÉCY, BATTLE OF; EDWARD (III) of England. PAUL M. KENDALL

EDWARD, LAKE. See LAKE EDWARD.

Edward VI

Culver

Edward VII

Visual Educ. Serv.

Edward VIII

Foulsham & Bansfield

Edward, the Black Prince

Brown Bros.

EDWARD THE CONFESSOR (1002?-1066), the last English king descended from Alfred the Great, succeeded his half-brother, Hardecanute, in 1042. Edward was a weak ruler. Most of his reign was dominated either by his father-in-law, Godwin, Earl of the West Saxons (d. 1053) or by Norman advisers and friends whom he advanced to important positions in the government and Church.

Visual Education Service

The Statue of Edward the Confessor stands in Westminster Abbey in London.

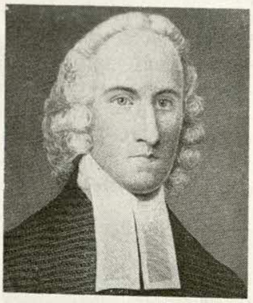
Edward was a pious man. He founded Westminster Abbey, which was completed in 1065 (see Westminster Abbey). Pope Alexander III canonized him in 1161 with the title of Confessor.

Edward was childless, and the great problem of his later years was the succession to the throne. William, Duke of Normandy, claimed the throne by Edward's grant. Harold, Godwin's son, claimed it by Edward's deathbed concession and the choice of the nobles. This dispute made a war for the kingdom inevitable (see William [I, The Conqueror] of England).

Robert S. Hoyt

EDWARDS, JONATHAN (1703-1758), an American Congregationalist clergyman, was the outstanding theologian and scholar of colonial New England in the 1700's. In his most famous book, *Freedom of the Will* (1754), he upheld such Calvinistic doctrines as predestination (see Calvin, John). But he insisted that man had freedom to choose alternative courses when forces outside him "inclined" his will to choose.

Edwards was born on Oct. 5, 1703, in East Windsor, Conn. He received A.B. and A.M. degrees from Yale University. In 1727, he was ordained and installed as assistant in the church of Solomon Stoddard, his grandfather, at Northampton, Mass. When Stoddard died in 1729, Edwards became pastor. The religious revival, a part of the Great Awakening, came to his church in 1734. His famous sermon, "Sinners in the Hands of an Angry God" (1741), was preached during this revival. Edwards' discipline of young people for reading "immoral" literature and his refusal to give communion to unconverted church members caused his dismissal in 1750. He then served as a missionary to the American Indians in Stockbridge, Mass., from 1751 to 1757.



Brown Bros.

Jonathan Edwards

Edwards became president of the College of New Jersey (now Princeton University) in 1758, but died that year of smallpox.

Earle E. Cairns

EDWARDS, NINIAN. See Illinois (Famous Illinoisans).

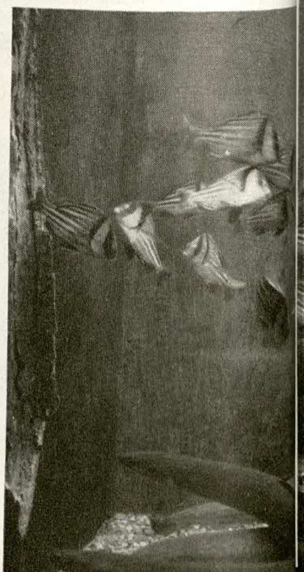
EDWARDS AIR FORCE BASE, Calif., is the home of the United States Air Force Flight Test Center. This command tests new aircraft and power plants. Most flying at the center involves forthcoming aircraft models. The center includes an experimental flight test school. The school trains select pilots to conduct flight tests of experimental and production aircraft. The base is one of the largest air force installations in the area. It covers 300,000 acres on the western edge of the Mojave Desert, 110 miles northeast of Los Angeles. The air force uses Rogers Dry Lake as a landing field. This lake is dry about 10 months a year. The center was established in 1946. It was later named for Capt. Glen W. Edwards, a pilot killed during a test flight of an experimental aircraft.

John H. Thompson

EEL is a fish so long and thin that it looks like a snake. Most eels live in the ocean. These salt-water, or marine, eels include the *conger eels* and the large, fierce *moray eels* of coral reefs. But man knows more about the kind that spends most of its life in fresh water. The streams of Europe and eastern North America contain fresh-water eels. Eels usually grow to a length of about 3 feet, but large ones may be 5 or 6 feet long. These fishes have tiny scales embedded in a smooth, slimy skin. Their long wriggling bodies are flattened at the tail.

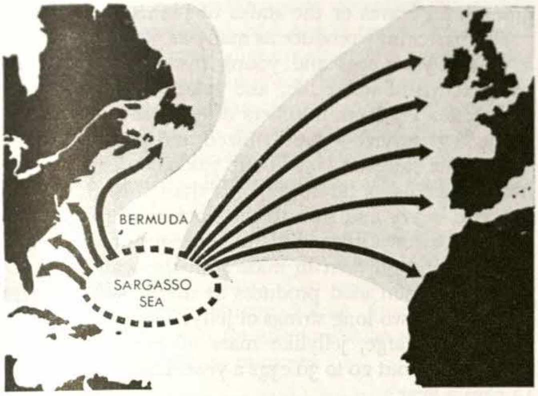
Both European and American eels have breeding grounds around the Bermuda Islands. They swim out from the fresh-water streams into the ocean only at spawning time when they are ready to lay their eggs in the fall. The parent eels spawn and then die. The young appear sometime during the following spring. When small, they are so thin and transparent that the print on this page could be read through their bodies. Young American eels appear in fresh-water streams the second spring, at the age of one year. They are then about 3 inches long. The European species do not appear in rivers until the third year. Naturalists call young eels that migrate upstream *elvers*. Females go far inland, but the males remain in tidal waters.

Eels are caught as they are migrating downstream to lay their eggs in the sea. They are taken in nets, by hand and set lines, and small wire traps called eelpots. They can also be speared while lying in the mud. Their flesh makes good food. Anglers catch eels for sport, called



Fresh-Water Eels of North America spend most of their lives in streams along the eastern coast of the United States. They swim into ocean water around the Bermuda Islands only at spawning time.

N.Y. Zoological Society



Breeding Ground of the Common Eels of North America and Europe. The adult eels swim toward mid-ocean, where their eggs are laid and fertilized. The young eels swim after a time to the rivers from which their parents came. Here they grow up before going back to the sea to lay their own eggs.

bobbing for eels. For bait, they string worms on a thread and double it into a bunch. This bait tempts the eels so much that they cling to it with their sharp teeth, and will not let go.

Scientific Classification. Fresh-water eels belong to the family *Anguillidae.* The European eel is genus *Anguilla,* species *anguilla.* The American is *A. bostoniensis.* The conger eel belongs to the family *Congridae.* It *is Conger conger.* Moray eels belong to the family *Muraenidae.* They are *Enchelycore nigricans.* CARL L. HUBBS

See also ELECTRIC EEL; FISH (color picture, Fresh-Water Fishes); LAMPREY.

EELGRASS is either of two different underwater plants. One grows in salt water, the other grows in fresh water.

Marine eelgrass grows in muddy, shallow bays along the Atlantic and Pacific coasts of North America. It roots on the ocean bottom and bears slender, floating stems. Its tapelike leaves may be 6 feet long. Wild ducks and geese eat the plants. About 1930, the eelgrass along the Atlantic Coast began to die. However, the plants have begun to grow again in some places.

Fresh-water eelgrass is also known as *tape grass* and *wild celery.* It grows in the mud of shallow ponds, sending up ribbonlike leaves directly from the root.

Scientific Classification. Marine eelgrass belongs to the pondweed family, *Potamogetonaceae.* It is genus *Zostera,* species *marina.* Fresh-water eelgrass belongs to the frogbit family, *Hydrocharitaceae.* It is genus *Vallisneria,* species *americana.* RICHARD W. POHL

EELLS, CUSHING. See WASHINGTON (Famous Washingtonians).

EELWORM is any of several small worms that look like a thread. Some live as parasites on plants, and cause important plant diseases. Others are insect parasites. Many kinds, however, live free in water and soil. Some female eelworms can lose their threadlike form and take the shape of a ball or lemon. Sometimes they give off a fluid which hardens around them into a brown case, or *cyst.* Then they may be scattered by wind and dust. Some harmful kinds of eelworms form hard swellings, called *galls,* in grain and grasses. Others injure the stems or roots of citrus fruits, coffee, and cereals, as well as garden plants. Farmers may have to rotate the crops in a field to get rid of these worms.

Scientific Classification. Eelworms belong to the phylum *Nematoda.* J. A. MCLEOD

See also GALL; ROTATION OF CROPS.

EFFICIENCY, in physics, is the amount of energy we get *out* of a machine divided by the amount of energy put *into* the machine. The difference between the work put in and the work delivered usually appears in the form of heat due to friction. For example, most of the electrical energy going into an electric motor is put out as mechanical energy by turning a shaft that does useful work, such as pumping water or drilling. But part of the energy given to the motor is wasted as heat in the bearings and wires. Scientists express efficiency in percentage. If a motor returns three fourths of the energy put into it, it has an efficiency of 75 per cent. An automobile engine has an efficiency of only about 25 per cent. Human beings have an efficiency of about 24 per cent. An electrical transformer can be over 98 per cent efficient. See also ENERGY; MACHINE. IRA M. FREEMAN

EFFIGY MOUNDS NATIONAL MONUMENT is in northeastern Iowa, 15 miles from McGregor. It contains prehistoric mounds and fortifications. Some of the mounds are 300 feet long and were built in the form of animals. The site also contains old cave shelters. The 1,204-acre monument was established in 1949.

EFT. See NEWT.

EGBERT (775?-839) was King of Wessex in England from 802 to his death. The King of Mercia drove him into exile in 789 (see ANGLO-SAXON). Egbert lived in Gaul for three years, where he saw the expansion of Charlemagne's empire. After gaining the West Saxon throne, Egbert destroyed the supremacy of Mercia in England. By conquering Cornwall, Kent, Surrey, and Sussex he permanently enlarged Wessex and made his kingdom supreme. The Mercians, East Anglians, and Northumbrians recognized his overlordship. His reign foreshadowed the later growth of a united kingdom of England. ROBERT S. HOYT

EGERIA, *ee JEER ih uh,* was a water-nymph in Roman mythology. She fell in love with King Numa Pompilius and became his wife. Her advice on religious matters was very helpful to him. After he died, Egeria wept so much that Diana changed her into a spring of water. See also NUMA POMPILIUS.

EGG. Most people think of an egg only as a kind of food produced by chickens. But all birds lay eggs, although few besides chicken eggs are used as human food. And many other kinds of animals produce eggs, including worms, fishes, reptiles, insects, and mammals such as the sow and the cow. In all ranks of animal life above the very lowest, it is impossible for young animals to be produced except from eggs.

The main purpose of all eggs is to produce young. The bird's egg is much larger than the mammal's egg because the bird's egg must contain food for the young bird to use while it is developing outside its mother's body. Most young mammals develop within the mother's body, and get their food from their mother until they are ready to be born.

In the case of birds, insects, and most fishes and reptiles, the fully formed egg is forced out of the body of the female that produced it. When the egg is kept under proper conditions for a certain length of time, it develops into an animal like its parents. In the case of nearly all mammals, the egg develops within the body of the female. In due time a young animal, such as a pig or a calf, is born.

Kinds of Eggs

Birds' Eggs vary greatly in size, shape, and in color (see Bird [color picture, Birds' Eggs]). Usually, the larger birds lay the larger eggs. For instance, the ostrich lays a very much larger egg than the hummingbird. There are exceptions, however, The Indian Runner duck, for example, is smaller than the Plymouth Rock hen, but lays a larger egg. The number of eggs which the different kinds of wild birds lay varies greatly. The hornbill lays one egg a year. Pigeons usually lay only two to four eggs a year, and gulls four. The gray-leg goose lays five or six eggs, the mallard duck nine to 11, and the ostrich 12 to 15. The partridge may lay 12 to 20 eggs a year. Hens and ducks can lay up to 350 eggs or more in a single year. Most wild birds lay their eggs in carefully built nests. A few lay their eggs on ledges of rocks, and others bury their eggs in the sand. Still others make a pile of decaying plants and bury their eggs in it. Wild birds' eggs have a wide range of colors, from the white of the flicker's egg to an almost solid black in the eggs laid by some ducks. There is a great variety of color patterns and markings of blues and browns among the eggs laid by other wild birds. It is frequently possible to identify a wild bird by its eggs. Leghorn and Minorca hens lay white-shelled eggs. Most other breeds of chickens lay brown-shelled eggs, but the Araucana hens of South America lay blue-shelled eggs. Most wild birds' eggs are similar in shape to the tame hen's egg. Some are very different in shape. The plover's egg is pear-shaped, and the owl's egg is round. The sand grouse's egg is shaped like a cylinder.

Other Kinds of Eggs. There are many kinds of eggs. The earthworm lays eggs enclosed in capsules filled with a milky nourishing fluid. The female water-flea produces summer eggs, which she carries in a pouch on her back, and winter eggs, which are enclosed in capsules. The eggs of moths, butterflies, and other insects are very small. They have many different forms and colors. These insects usually lay their eggs in clusters on the ground, on leaves or the stalks of plants, or in water.

The oyster may produce as many as 500,000,000 eggs a year. Oyster eggs and young oysters are eaten by many forms of water life, and relatively few survive. Fishes also lay large numbers of eggs, so that enough of the eggs survive to be fertilized and produce young fishes. The sturgeon lays about 7,000,000 eggs a year. Most other fishes lay fewer eggs than this. Some fish eggs are heavy and sink to the bottom of the stream, lake, or ocean. Other kinds of fish eggs are light and transparent, and float in masses on the water.

The common toad produces as many as 6,000 eggs at a time in two long strings of jelly. The common frog produces a large, jellylike mass of eggs. Egg-laying snakes lay about 20 to 30 eggs a year. Lizards lay about 12 eggs a year.

The Parts of An Egg

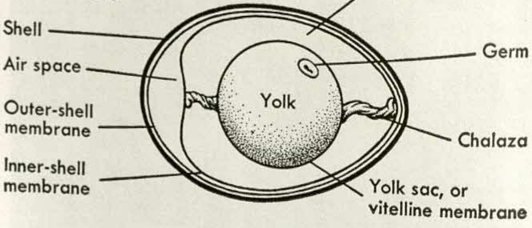
The most important part of an egg is the *germ*, or nucleus. This part develops into the new animal. The other elements or parts of an egg provide food and protection for the young animal.

A bird's egg has five principal parts. These parts are the shell, the shell membranes, the white, the yolk, and the germ.

The Shell is composed of four layers. Each layer is porous, so that water and gases can pass through it. On the outside of a fresh egg there is a jelly-like covering called *bloom* which tends to shut the pores tight. Eggs laid by different hens sometimes differ a great deal in thickness of shell and the size and number of pores.

Shell Membranes. Placed just inside the shell there are two very thin white skins, or *membranes*. These are the outer-shell membrane and the inner-shell membrane. They lie close to each other, except at the large end of the egg, where they are separated to form the air cell. Water and gas can pass through these membranes. When the egg is laid, it contains either no air cell or a very small one. The longer the egg is kept, however, especially in a dry, warm place, the larger the air cell becomes. This is because water and gas escape from the egg and leave more spaces. The shell membranes surround the white, or *albumen*, portion of the egg.

The White of an egg is made up of four different parts. First there is a layer of thin white, then a layer of thick white, and then another layer of inner thin white. Inside this innermost layer of thin white, there is a layer of thick white surrounding the yolk. This layer of thick white is twisted in a ropelike structure at each end of the yolk and forms what is known as a *chalaza*. The chalazas keep the yolk afloat about in the center of the egg, and permit it to turn easily. They tend to keep the yolk from being damaged.


PARTS OF A BIRD'S EGG

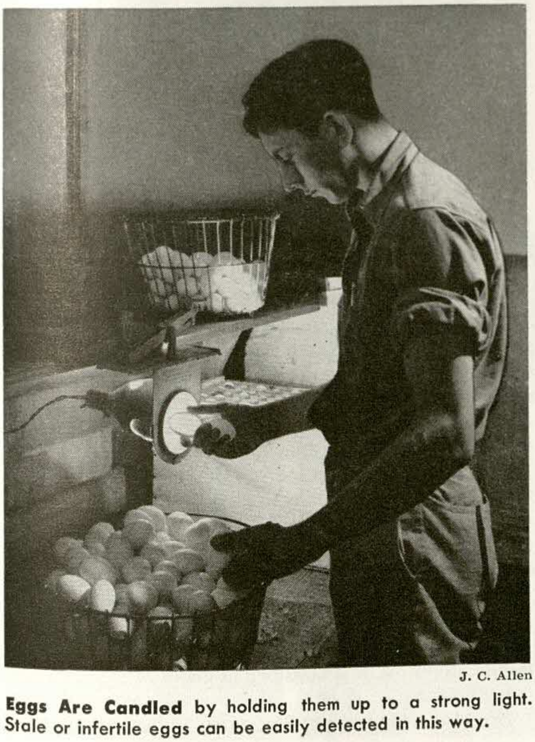
The Yolk is contained in a yolk sac called the *vitelline membrane*. When a fresh-laid egg is resting on its side or end, the yolk stays slightly above the center of the egg because the yolk is lighter than the white. As the egg is in a resting position, there is an area of small size known as the *germ* on the upper surface of the yolk. The germ in a fertile egg that is kept under suitable conditions develops into the embryo. A two-yolk egg may be fertile, but it will not hatch.

Since the purpose of the egg is to produce young, the contents of the egg make up a well-balanced diet for the developing embryo. The eggshell is composed almost entirely of carbonate of lime. This provides the embryo with calcium for the formation of bones and for other body-building purposes.

Development of the Bird's Egg

The egg begins its development in the ovary of the female. Each reproductive cell is called an *ovum*. It is contained in a very thin envelope called the *follicle*, which is attached to the ovary by a very slender stalk. Many ova are present in the ovary, especially in a bird in laying condition. Yellow and white yolk granules accumulate in layers within the ovum until the yolk of the egg becomes as large as that seen in the fresh-laid egg. At that stage of development the follicle bursts along a streak called the *stigma* and the yolk is freed from the ovary.

The yolk is grasped by the mouth of the oviduct, where the rest of the egg is formed. As the yolk is forced through the oviduct, glands in the middle part of the oviduct deposit the different layers of white around the yolk. The shell is formed in the lower part of the oviduct. From the time the yolk enters the oviduct until the completed egg is laid requires a little over 25 hours in the case of the domestic hen. Usually eggs are laid small end first.



J. C. Allen

Eggs Are Candled by holding them up to a strong light. Stale or infertile eggs can be easily detected in this way.

Domestic hens lay at any time of the year, although egg production is highest during the spring months. The ancestors of domestic hens, however, normally laid during the spring months only. Nearly all wild birds lay in the spring. Birds respond to the gradual increase in the amount of daylight or sunlight during the spring months. A tiny gland, the *pituitary*, located at the base of the brain, secretes hormones. These speed up the development of the ova. The action of light influences the activity of the pituitary gland. The bird's eye is sensitive to the intensity of the light. When the light increases, more of the hormone is secreted. The hormone secretions are circulated throughout the blood, and stimulate the bird to start laying eggs.

How Embryos Develop

In mammals, snakes, turtles, and insects, mating takes place between the sexes and eggs are fertilized within the body of the female.

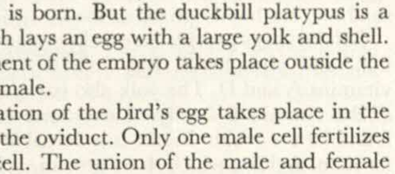
Toads and frogs also mate, but the eggs are fertilized after they are freed by the female. Frogs' eggs will develop into tadpoles if the surface of each egg is punctured with a very fine needle. The eggs of the sea urchin may also be made to develop without natural fertilization if they are treated with certain chemicals. Most fishes do not mate. The male deposits his reproductive cells near the eggs after they are laid.

In most mammals, the development of the embryo takes place within the body of the female until the young animal is born. But the duckbill platypus is a mammal which lays an egg with a large yolk and shell. The development of the embryo takes place outside the body of the female.

The fertilization of the bird's egg takes place in the upper part of the oviduct. Only one male cell fertilizes each female cell. The union of the male and female reproductive cells makes possible the development of the embryo in the egg. The fertilized cell begins to divide, and many cell divisions are completed before the egg is laid.

The egg of the domestic hen must be kept at the proper temperature or incubated for 21 days before the chicks will hatch. Most duck eggs incubate for 28 days, but Muscovy duck eggs require 35 days. Turkey and guinea eggs must be incubated for 28 days, goose eggs from 32 to 35 days, quail eggs 22 to 24 days, and pheasant eggs 23 to 28 days depending on the variety. The eggs may be incubated under hens or in incubators.

FOOD VALUE OF
A HEN'S EGG



Electric incubators have a constant temperature of around 98¼° to 98½°F. The business of incubating eggs of chickens and turkeys in the United States has developed so widely that by far most of the chickens and turkeys raised each year are hatched in commercial hatcheries. Some hatcheries hold over a million eggs at one setting.

At the time the egg is laid, the cells of the germ have already begun to divide and develop. At this stage the germ is made up of two layers of cells. The outer layer is called the *ectoderm* and the inner layer the *endoderm*. Under proper incubation, the cells continue to divide rapidly and the embryo begins to take shape. The two layers of cells soon become three layers. The *mesoderm* arises between the ectoderm and the endoderm. The ectoderm grows into the skin, feathers, and other external features, as well as the nervous system. The mesoderm grows into the bones, blood, muscles, and reproductive and excretory organs. The endoderm develops into the respiratory and secretory organs and the linings of the digestive tract. The white of the egg serves as the principal source of nourishment for the embryo for the first two weeks. After this time the yolk provides the necessary nourishment for the third week.

Uses of Eggs

Chicken eggs form an important part of man's diet. In Great Britain and The Netherlands, duck eggs are widely used. In China, eggs are pickled and preserved for 100 days to form *ancient eggs*. People in some countries consider the egg of the plover a delicacy. Turtle eggs are used in turtle soup, and fish eggs, especially shad roe, are highly prized as food.

Chicken eggs provide an excellent source of proteins, iron, and phosphorus. Egg yolk is a rich source of vitamins A and D. The yolk also has *biotin*, a member of the vitamin B family. A substance called *avidin* is found in the white. Biotin is a valuable food element for man. Avidin, which slows growth, is harmful. Eggs also contain some thiamin and riboflavin.

White and brown eggs have the same food value. Eggs with dark spots on the surface may be used for food. The United States Department of Agriculture classifies such eggs as Grade C. Its other three grades are AA, A, and B. These standards are based on the condition of the shell, yolk, and white.

The white begins to harden at about 134°F. when an egg is cooked. Eggs form the chief ingredient of omelets. They may be used to make soups clear. Frozen and dried eggs are important in baking and cooking.

Eggs are used for other purposes than as food. They are used to prepare vaccines, animal feeds, and fertilizers. Manufacturers use eggs in producing paints, varnishes, ink, soap, shampoos, and printer's ink.

Leading egg-producing countries include the United States, Great Britain, France, and Japan. For a list of the leading egg-producing states, see CHICKEN (table, Leading Egg Producing States). MORLEY A. JULL

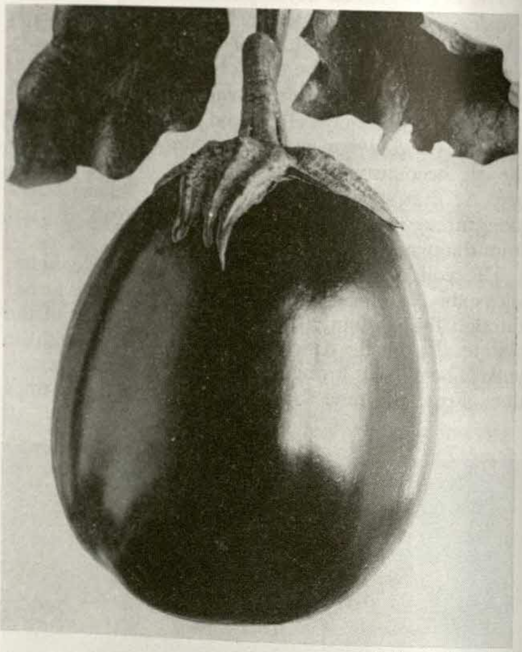
Related Articles in WORLD BOOK include:

Albumin
Bird (Eggs; color pictures)
Caviar
Chicken
Embryo
Fish (Reproduction)
Fossil (picture, Dinosaur Egg)
Insect (Life Histories)
Poultry

EGG ROLLING. See EASTER EGG ROLLING.

EGGLESTON, *EG'l stun*, **EDWARD** (1837-1902), wrote *The Hoosier Schoolmaster* (1871), a fresh, delightful story of early Indiana. The book is important because it was one of the first attempts to write a story about American regional life in the West. *The End of the World* (1872) deals with the Millerites, a religious group that expected Christ's second coming in 1843. *The Graysons* (1887) shows Abraham Lincoln as a young lawyer. Eggleston was born at Vevay, Ind. Besides being a writer, he was also a Methodist circuit rider and an historian. EDWARD WAGENKNECHT

EGGPLANT is a vegetable that bears large purple fruits shaped like an egg. Explorers first found eggplants in South America, but the vegetable now grows in many tropical lands, and as far north as New York. The eggplant grows on a bush that stands two or three feet high. The fruit hangs among the grayish-green hairy leaves, and sometimes grows nearly as large as a football. It grows only in warm weather, and takes 115 to 120 days to ripen. Where the warm season is too short, the seeds must be planted in a greenhouse. Then the seedlings are transplanted after warm weather begins. The crop is hard to grow. Little black flea beetles nearly always attack the eggplants as soon as the seedlings are set in the garden. They eat many small holes in the leaves, and weaken the plants. Malathion is a poison often used against these beetles. People have used eggplant as food since about 1860. The vegetable has few calories or vitamins, but is rather popular. It tastes good baked or French fried.



J. Horace McFarland

The Shiny Purple Fruit of the Eggplant, which is now a popular vegetable, was at one time believed to be poisonous.

Scientific Classification. The eggplant belongs to the family *Solanaceae*. It is classified as genus *Solanum*, species *melongena*. ARTHUR J. PRATT

See also NIGHTSHADE; SOLANUM; VEGETABLE (table).

EGLANTINE, *EHG luhn tyne,* is a wild rose, commonly called *sweetbrier.* The plant grows as a shrub, and sometimes reaches a height of 6 feet. The eglantine has curving brown stems covered with sharp, hooked thorns. The leaves are small and grow close together. They are dark green on top and pale green underneath. The flowers are a soft pink color. Both the leaves and blossoms have a sweet, spicy scent. The plant bears bright red or orange fruits. These fruits appear after the flowers have fallen. The eglantine originally came from Europe. It grows in parts of the eastern United States.

Scientific Classification. The eglantine belongs to the family *Rosaceae.* It is classified as genus *Rosa,* species *rubiginosa.* J. J. Levison

See also Flower (color picture, Flowers of the Roadside, Field, and Prairie).

EGLIN AIR FORCE BASE, Fla., is the home of the U.S. Air Force Air Proving Ground Center. It covers 465,000 acres and lies 54 miles east of Pensacola. The center tests all air-force aircraft and supporting equipment. Its armament division develops all air-force weapons except atomic types. The base was established in 1935 as the Valparaiso Bombing and Gunnery Base. It was later named for Lt. Col. Frederick I. Eglin, who died in an aircraft accident in 1937. John H. Thompson

EGO, *EEgoh,* in a nontechnical sense, is used to mean one's self, one's self-esteem or pride, or even as a synonym for egotism. In *psychoanalysis,* those activities of the mind that deal with a person's relation to his environment are called the ego. Some of these activities of the mind are conscious, but some are not.

Important ego functions include memory; such means of perception as seeing, hearing, and feeling; and voluntary control of bodily movements such as walking. The ego also controls wishes or impulses that might not be acceptable to other people. This leads to conflicts (opposition) between the ego and certain impulses. Psychoanalysts have shown that everyone has such ego-impulse conflicts. Charles Brenner

See also Psychoanalysis.

EGOIST. See Altruist.

EGRET, *EEgret,* is the snow-white heron, the bird that grows the long plumes hatmakers or milliners call *aigrettes.* Several species live in America, mostly in the southern states. The tall, handsome *American egret* and the *snowy egret* have the finest plumage. A third species is the *reddish egret,* and a fourth is the *cattle egret.* The cattle egret came originally from Asia, and lives in Florida.

Plume hunters used to kill so many egrets that there was danger none would be left. But the Audubon Society, and state and federal game wardens now protect them, and their number is increasing. The United States has sanctuaries to protect these birds in South Carolina, Florida, Louisiana, and Texas. Two species of egrets live in Europe, a large and a small one. Egrets are especially numerous in India.

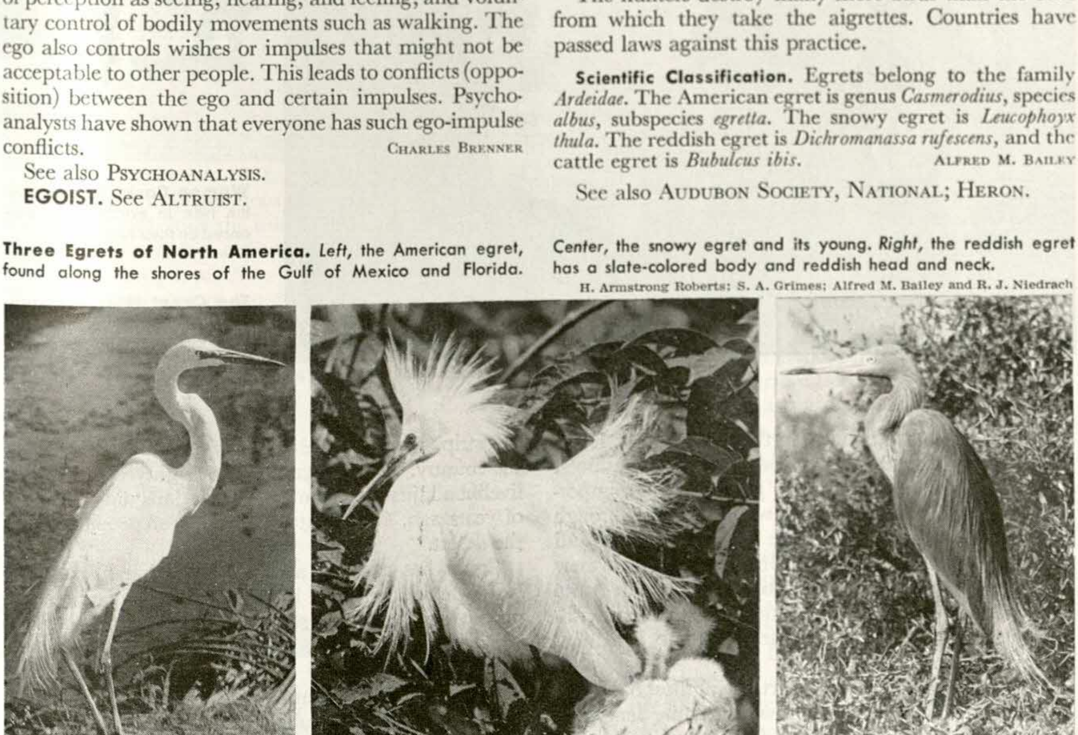
Since earliest times, people of high rank in Oriental countries have worn egret plumes, called *aigrettes.* Set with jewels, they were marks of honor. The fashion spread to other countries, and aigrettes began to be worn on military hats. Women also used aigrettes as ornaments in their hair and on their hats.

So many people demanded these graceful plumes that more and more egrets were killed. Their numbers everywhere became much smaller. The valuable plumes grow between the shoulder blades of the birds, and extend over and beyond the tail. But they appear only on the adults, and during the nesting season. This means that when the parent birds are killed for their plumage, the young are helpless, and starve to death.

The hunters destroy many more birds than the ones from which they take the aigrettes. Countries have passed laws against this practice.

Scientific Classification. Egrets belong to the family *Ardeidae.* The American egret is genus *Casmerodius,* species *albus,* subspecies *egretta.* The snowy egret is *Leucophoyx thula.* The reddish egret is *Dichromanassa rufescens,* and the cattle egret is *Bubulcus ibis.* Alfred M. Bailey

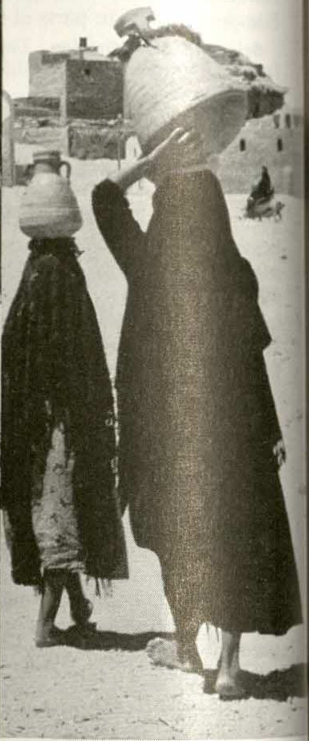
See also Audubon Society, National; Heron.



Three Egrets of North America. *Left,* the American egret, found along the shores of the Gulf of Mexico and Florida. *Center,* the snowy egret and its young. *Right,* the reddish egret has a slate-colored body and reddish head and neck.

H. Armstrong Roberts; S. A. Grimes; Alfred M. Bailey and R. J. Niedrach

EGYPT



Women Carry Water from the Nile in earthen jars balanced on their heads.

The Great Nile River provides transportation and turns desert into farmland.

H. Armstrong Roberts; Waagenaar, Pix

EGYPT is an Arab country in the Middle East. It lies in northeast Africa, and extends into the southwest corner of Asia. The Suez Canal gives Egypt an important role in world affairs. This waterway cuts through Egypt, providing a trade route between Europe and Asia. Egypt joined with Syria in 1958 to form a new nation, the United Arab Republic (see UNITED ARAB REPUBLIC). But in 1961, the Syrians revolted and withdrew from the U.A.R. Cairo, the largest city in Africa, is the capital of Egypt.

The wind-swept Sahara Desert covers most of Egypt, and the broad Nile River flows the entire length of the country. The Nile floods its banks every year, depositing fertile soil along a narrow strip of land. More than 95 of every 100 Egyptians live on this fertile strip, which makes up only about 3 per cent of the country. They depend on the mighty river for their livelihood, just as the ancient Egyptians did thousands of years ago. Only scattered groups of people live on the desert.

Egypt has an area a little larger than Texas and New Mexico together, but it has over twice as many people as those two states combined. Most of the people are quite poor. A few places have an up-to-date look, with large buildings, oil refineries, and huge dams. But the country looks much as it did when the pharaohs (kings) ruled the land several thousand years ago. For a description of life in ancient Egypt, see the separate article on EGYPT, ANCIENT. Egypt is a charter member of the United Nations.

FACTS IN BRIEF

Type of Government: Republic.

Capital: Cairo.

Official Language: Arabic.

Head of State: President.

Parliament: Council of the Nation, appointed by the president.

Area: 386,000 square miles. *Greatest distance:* (east-west) 760 miles; (north-south) 675 miles. *Coast line,* 600 miles (Mediterranean Sea), 1,200 miles (Red Sea).

Elevation: *Highest,* Gebel Katherina (8,652 feet above sea level). *Lowest,* Qattara Depression (436 feet below sea level).

Population: 26,080,000. *Density,* 67 persons to the square mile. *Distribution,* rural, 70 per cent; urban, 30 per cent.

Chief Products: *Agricultural,* barley, beans, corn, cotton, dates, millet, onions, rice, sugar cane, wheat, camels, cattle, donkeys, goats, sheep. *Mineral,* building stone, manganese, petroleum, phosphate rock. *Manufacturing,* fertilizer, paper, steel, sugar, textiles.

Flag: The flag has three equal horizontal stripes, red, white, and black (top to bottom). Two green stars appear on the white band. See FLAG (color picture, Flags of Africa).

National Anthem: "El Salaam El Gomhoury" ("National Anthem of the United Arab Republic").

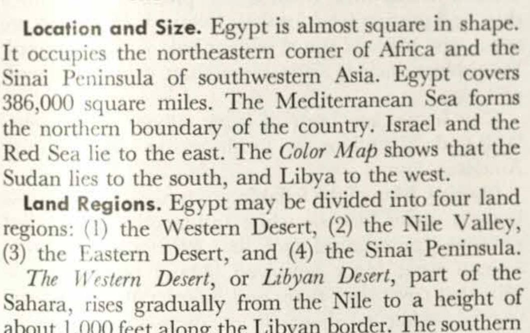
Money: *Basic unit,* Pound. One hundred piasters equal one pound. For the value of the pound in dollars, see MONEY (table, Values).

The Land and Its Resources

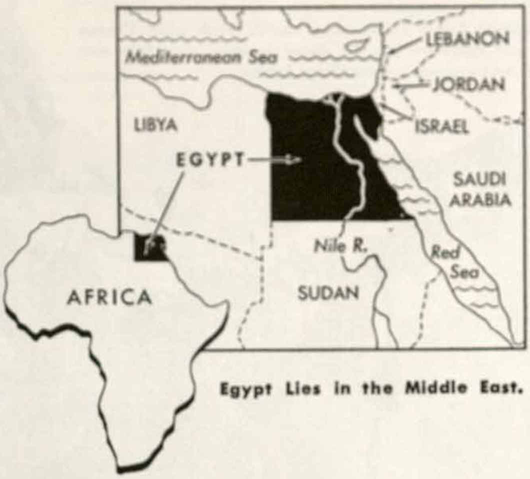
Location and Size. Egypt is almost square in shape. It occupies the northeastern corner of Africa and the Sinai Peninsula of southwestern Asia. Egypt covers 386,000 square miles. The Mediterranean Sea forms the northern boundary of the country. Israel and the Red Sea lie to the east. The *Color Map* shows that the Sudan lies to the south, and Libya to the west.

Land Regions. Egypt may be divided into four land regions: (1) the Western Desert, (2) the Nile Valley, (3) the Eastern Desert, and (4) the Sinai Peninsula.

The Western Desert, or *Libyan Desert,* part of the Sahara, rises gradually from the Nile to a height of about 1,000 feet along the Libyan border. The southern part of the desert is a region of wind-swept rocks and sand where few people live. Green *oases* dot the sands of the northern part of the desert. An oasis is a place in a desert where underground water works its way to the surface so that vegetation can grow. Several thousand persons live in the larger oases, such as Siwa, Bahariya, Dakhla, and Kharga. The best-known oasis is El Faiyûm. It lies about 50 miles southwest of Cairo.



Egypt Is One Ninth the Size of the United States.



Egypt Lies in the Middle East.

The Nile Valley is almost completely flat. It is divided into two sections, *Upper Egypt* and *Lower Egypt.* Upper Egypt is a 930-mile strip of the Nile Valley stretching northward from Adindân to Cairo. Cliffs line much of the valley, which averages from 10 to 14 miles in width. The valley contains fertile fields and historic ruins.

Lower Egypt covers the Nile delta between Cairo and the Mediterranean Sea. Seven branches of the Nile helped create the triangular-shaped delta. Lower Egypt also has a series of canals that serve as water highways and sources of irrigation. See DELTA; NILE RIVER.

The Eastern Desert, or *Arabian Desert,* stretches eastward from the Nile. This desert rises more than 7,000 feet in the highlands along the Red Sea. Coral reefs line most of the Red Sea coast line. North of the highlands, the Suez Canal links the Mediterranean and Red seas. See ARABIAN DESERT; SUEZ CANAL.

The Sinai Peninsula, in the northeast, is the highest region of Egypt. Many persons believe the peninsula's 7,400-foot-high Jebel Musa is Mount Sinai, on which Moses received the Ten Commandments from God.

Natural Resources. The rich soil along the Nile is the principal natural resource of Egypt. The marshes of the Nile delta contain salt beds. Miners dig granite and sandstone from the mountains east of the Nile. These building stones have been used for thousands of years. The land also has some coal and petroleum.

Climate. Egypt has a dry climate. It is hot in summer, with temperatures averaging between 80° and 90°F. Winters are warm, with temperatures averaging between 55° and 70°F. A steady wind from the northwest helps hold down the temperature near the coast.

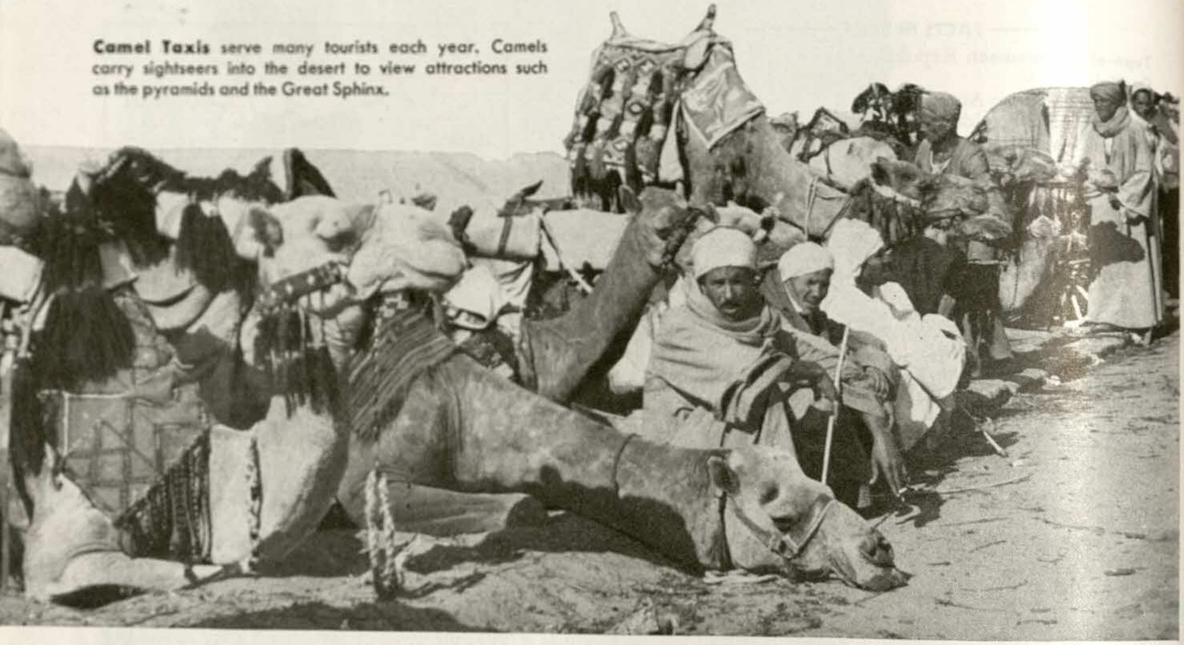
The *khamsin* is a wind that blows from the south in Egypt, usually in spring or summer. It brings sand and dust, and sometimes raises the temperature in the desert to more than 100°F.

Rain seldom falls in Egypt. Along the Mediterranean Coast, the average yearly rainfall is 8 inches. Farther south, only about 1 inch of rain falls every year.

Life of the People

The People. Most of Egypt's 26,080,000 people live in an area of about 13,600 square miles along the Nile

Camel Taxis serve many tourists each year. Camels carry sightseers into the desert to view attractions such as the pyramids and the Great Sphinx.



Waagenaar, Pix

River. Many places in the valley have more than 2,500 persons crowded into a square mile of land. Near Cairo, as many as 6,500 persons may live in one square mile. In contrast, few people live on the desert.

Egyptians are a mixture of many peoples. Their ancestors came from many lands over a period of thousands of years. Ancient Egyptians, Arabs, Turks, and other peoples are blended in their ancestry. In general, northern Egyptians have lighter hair and fairer skin than southern Egyptians.

Language. Arabic is the official language of Egypt. Many Egyptians also speak English, because the British occupied the country for many years.

Family Life. Egyptians can be divided into three main groups on the basis of their work and their way of life. Almost three fifths of the people are *fellahin* (pronounced *FEL uh HEEN*), or peasants. The average family of fellahin has four or five children, who start working as soon as they are able to do so. Most fellahin, especially the women, spend their lives in drudgery.

The *Bedouins* make up another and much smaller group of people. They are mostly tribes of nomads who roam the deserts and valleys in search of grazing land for their animals. Their families are about the same size as the fellahin families, except that many Bedouin husbands have from two to four wives. A sheik rules each tribe (see SHEIK).

The third and smallest group consists of the merchants and professional people who live in the cities. These people usually have two or three children.

Shelter. The fellahin live in one- or two-room huts made of mud from the banks of the Nile. The people mold the mud into bricks and bake them hard in the hot sun. The huts often have no windows, and sometimes have only flat coverings of palm branches for roofs. Furniture usually includes only a chest for clothes, a low table, and a few cushions and mats on the floor.

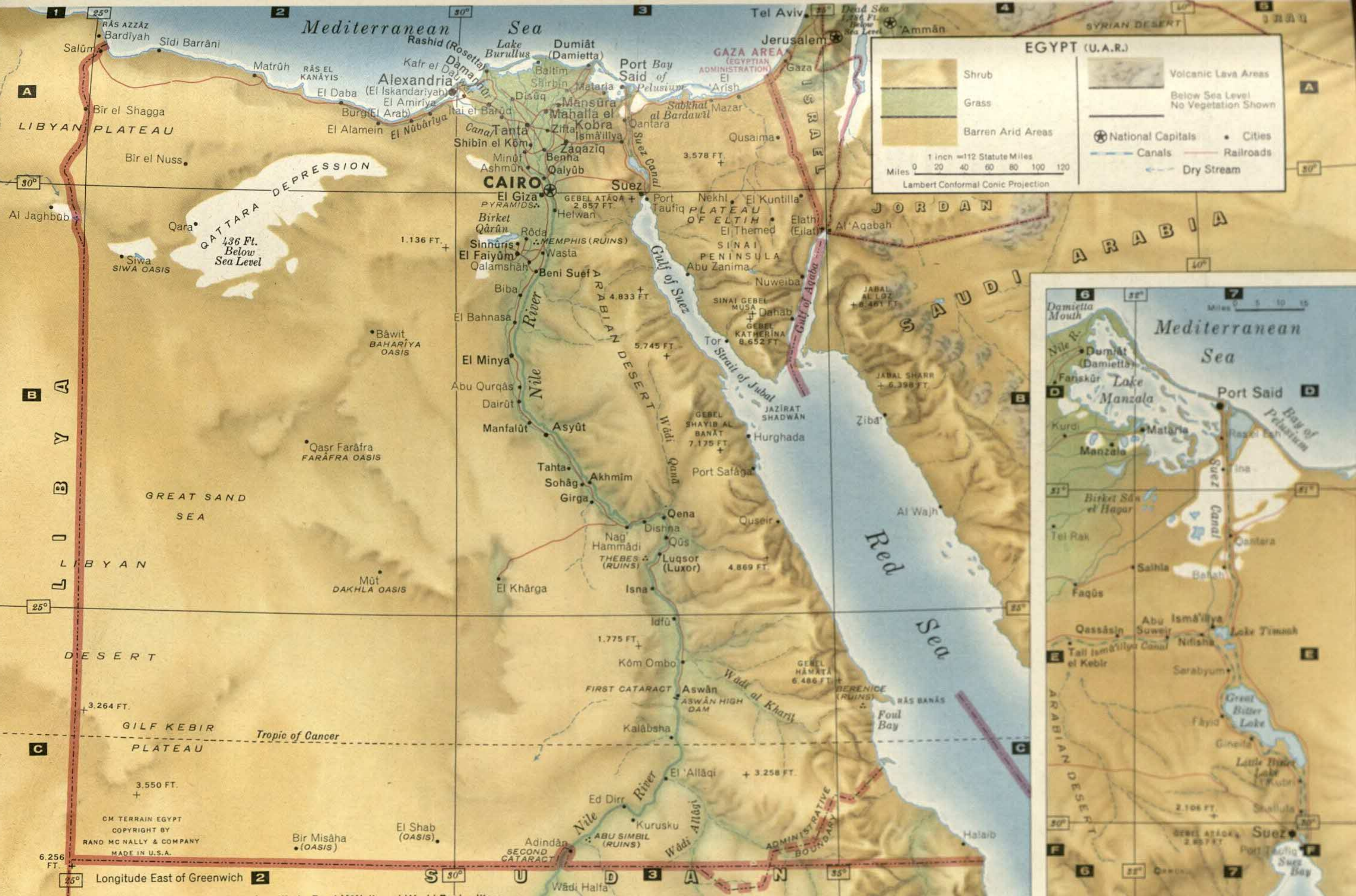
Some Bedouins have fairly permanent homes in tents pitched at the edge of the Nile Valley, or on the green land of desert oases. Most of them wander about the deserts, within their tribal areas, pitching tents when they find grazing land for their livestock. The tents are small, and made of camel or goat hair, or sheep's wool. Furnishings include little more than cooking utensils and rugs.

City homes are built of brick, stone, or concrete. Well-to-do Egyptians use furniture like that in North American homes.

Clothing. Men of the fellahin group wear baggy white trousers under blue or white full-length robes called *galibiyeh* (pronounced *gah lee BEE yeh*). Fellahin women wear black galibiyeh. Many of them wear veils that cover their noses and mouths. Both men and women either go barefoot or wear heelless shoes. Bedouin clothing is similar to that of the fellahin. They wear cloths over their heads to shade their eyes from the bright desert sun, and to keep sand and dust out of their eyes. Many city dwellers wear the same kinds of clothing that persons in North America wear. However, the men still wear the *tarboosh* (pronounced *tahr BOOSH*), a tall red hat with a black tassel (see FEZ.)

Food. The principal Egyptian food is a porridge consisting of dried brown beans or lentils baked for 24 hours and served with butter or olive oil and lemon. Mutton is the favorite meat, but few families can afford to buy it, except for special occasions. Instead, they eat inexpensive but filling food such as rice and cornmeal bread. Vegetables are always in season, and the people eat many of them, especially onions and tomatoes. Cheese is a common food, and so are such fruits as dates, figs, and apricots. Sweet Turkish coffee and dark tea flavored with herbs are the favorite beverages.

Recreation. The fellahin like music, and often sing as they work. Market places in cities and villages offer entertainment to passers-by. Dancing girls swirl to the music of the *kanoun* (pronounced *kah NOON*), a stringed instrument. Snake charmers and jugglers perform for the coins the audiences toss them.



Especially created for **World Book Encyclopedia** by Rand McNally and World Book editors

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Source: Latest available official figures.

* Population of metropolitan area, including suburbs.

* Place names marked by an asterisk do not appear on the map. Key shows general location.

Screen Traveler from Gendreau; Hubmann, Black Star

Irrigation Wheels lift water from an oasis in the Nile Valley onto nearby farm land.

Diesel Pumps Spout Water to irrigate many of Egypt's desert-dry fields. Mats protect young fruit trees from the blazing sun.

Soccer is the favorite outdoor game in Egypt. Many wealthy Egyptians enjoy tennis, swimming, sailing, and chess. One of Egypt's important festivals is *mawlid al-nabi* (Birth of the Prophet). It is celebrated for nine days, beginning in the third week of the Moslem year.

City Life. Egypt has seven cities with more than 100,000 persons. They all lie in the north on navigable bodies of water.

The new sections of the cities have handsome modern buildings, wide streets, and beautiful parks. The old sections are jammed with tightly packed buildings, narrow, twisting streets, and crowded market places. In the late 1940's, a housing project called Worker's City was begun outside of Cairo. See the list of articles on cities in the *Related Articles* at the end of this article.

Country Life. Villages often stand on the desert at the edge of the Nile Valley so that buildings do not take up valuable farm land. Most villages are mere clusters of small mud buildings. The streets are narrow and unpaved. The strong smell of burning cow manure fills the air. Most Egyptians use dried manure for fuel because the country has few other fuel sources.

Work of the People

Egypt has been an agricultural country for thousands of years. But during the 1950's the value of industrial production began to increase. Much of this industrial development resulted from the Agricultural Reform Law of 1952. This law provided that no person could own more than 200 feddans (207 acres) of farm land. The government bought the vast estates of former days and divided them among the landless fellahin. As a result, the wealthy people invested in industry because they could no longer put their money into land.

Agriculture is the chief industry. About three fourths of the people make their living from it. The farms are small, many of them less than one acre in size. This is because there are many farmers, and only about 8,000,000 acres of land along the Nile can be cultivated.

Irrigation makes farming possible along the Nile. Little rain falls in this area. At one time, the land could be irrigated only from June to September, when the river overflowed its banks. Floodwaters left fresh soil on the farms, and the farmers planted and grew their crops while the soil was still moist.

Since the 1830's, the government has built several huge dams, called *barrages*, across the Nile, to store the floodwaters in reservoirs. Water behind the dams can be released when it is needed, and canals carry it to the fields. Farmers grow two or three crops every year.

In places where low cliffs line the Nile, farmers usually water their fields by hand. They raise water from the river by *shadoofs* (pronounced *shah DOOFS*), or water lifts with a bucket at the end. They also use a water wheel called a *sakieh* (pronounced *SAK ih eh*). A cow, ox, or camel pulls the wheel around to raise water in a series of buckets held by chains.

Egypt's most important crop is long-staple cotton. Most of it grows in the Nile delta. Cotton plantations take up one fifth of the cultivated land. The Civil War in America was chiefly responsible for the development of cotton growing in Egypt. The war cut off shipments of American cotton to Europe, and European textile industries needed a new source for the plant.

Other crops include corn, sugar cane, rice, barley, millet, and wheat. Fruits such as oranges, apricots, melons, dates, figs, tangerines, and pomegranates grow in the oases. Egypt has several million cattle, sheep, and water buffaloes.

Manufacturing and Processing. The cotton-textile industry, with more than 150,000 workers, is the largest manufacturing industry. One of the largest sugar refineries in the world is in Nag Hammâdi. Other important manufactured products include paper, fertilizer, steel, cement, cigarettes, chemicals, and metal products such as nails and pipes.

Mining. Both sides of the Gulf of Suez contain rich petroleum beds. A $10,000,000 government refinery, completed in 1956, processes much of this oil. The Sinai Peninsula also furnishes manganese. Great quarries in the eastern highlands yield granite, sandstone, limestone, and a little gold. Iron ore deposits lie near Aswân and El Baharîya. Egyptians also mine salt, phosphates, alum, and gypsum.

Power. A lack of fuel and water power has hindered industrial development. Most of the electric power is generated from imported oil and coal, although petroleum fields along the Gulf of Suez provide some fuel.

Trade. The value of Egyptian imports is greater than that of the exports. The most important imports include iron and steel products, machinery, fertilizers, chemicals, and woolen goods. Cotton makes up three fourths of the exports. Egypt also exports foodstuffs. Egypt trades chiefly with France, Germany, Great Britain, Italy, India, and the United States.

Transportation. Most of Egypt's transportation facilities are along the Nile and the Mediterranean. Camels carry passengers and goods over desert sands where there is no other means of transportation.

Waterways are the chief routes of travel. *Dhows* and *feluccas*, two kinds of flat-bottomed sailboats, use the Nile. Motor-driven barges are also widely used. Thousands of ships steam through the Suez Canal every year.

Shipping. Egypt has over 30 merchant ships. Leading Mediterranean ports include Salûm, Sîdi Barrâni, Alexandria, and Port Said. Important Red Sea ports include Suez, Port Safâga, and Quseir.

Aviation. National and international airlines serve Egypt. The main airport is Cairo's International Airport.

Railroads link the major cities. The country has about 4,000 miles of railroads. The first railroad in Africa began operating in 1852 between Cairo and Alexandria.

Roads and Highways. A system of roads and highways covers the settled part of the country. There are about 9,000 miles of roads, most of them unpaved.

Communication. Egypt has several newspapers, magazines, and book-publishing firms. Most of them are in Cairo and Alexandria. Radio stations broadcast from Cairo and Alexandria. Telephone and telegraph lines link all the major cities.

Activities of the People

Education. Elementary-school education is free. The law requires children between the ages of 6 and 12 to go to school. But many children do not attend school. This is partly because their parents need the money the children can earn if they work, and partly because there are not enough schools and teachers. There are also free high schools and technical schools. All schools must teach each student his own religion.

Egypt has several universities, most of them in Cairo. The University of Al-Azhar at Cairo is the oldest university in the world. It was founded about A.D. 970, and is probably the leading Islamic school in the world.

Religion. More than 91 of every 100 Egyptians are Moslems (members of the Islamic faith). The most common Egyptian branch of the faith is the *Sunnite*. Cairo is the center of Islam in Egypt. More than 250 *mosques* (Moslem houses of worship) stand in the city. See Islam; Moslems.

About 8 of every 100 Egyptians are *Copts*. The Coptic religion is a Christian religion, but it is separate and different from other branches of the Christian church (see Copts). The rest of Egypt's people belong to other Christian denominations, or are Jews.

The Arts. Modern Egypt has produced no world-famous composers, writers, or artists. But the country is the scene of many well-known compositions, books, plays, and paintings. For example, Giuseppe Verdi's opera *Aïda* is set in Egypt. For descriptions of the arts of ancient Egypt, see Egypt, Ancient.

What to See and Do in Egypt

Greek and Roman tourists visited Egypt more than 2,000 years ago to gaze upon the wonders of the past, just as do tourists from all parts of the world today. Many visitors ride camels on sight-seeing trips into the desert.

Well-known sights include the Great Sphinx and the pyramids near El Gîza, the tombs in the Valley of the Kings near Luxor, and the mosques in Cairo. See Cairo; Pyramids; Sphinx; Valley of the Kings.

Bible students like to visit the scenes of Old Testament events. A visit to the museums gives the tourist a picture of Egypt's past. The most important museums are the Egyptian Museum in Cairo, the Roman Museum in Alexandria, and the Coptic and Arab museums in Cairo.

Government

On Feb. 21, 1958, Egypt became a province within the United Arab Republic, established by the union of Egypt and Syria. The 1956 constitution was replaced by the constitution of the United Arab Republic. The new constitution gave Egypt two types of government, one national and one provincial. Syria left the United Arab Republic in 1961.

National. Executive power in the United Arab Republic is placed in a president. He appoints ministers who are responsible to him. Legislative power rests in a Council of the Nation. Its members are chosen by the Republic's president.

Provincial government in Egypt is controlled by an executive council. The president appoints its chairman. Ministers help to administer the provincial government. They are appointed by the president on the recommendation of the chairman of the Executive Council, and can be dismissed from office at any time.

Courts. Egypt's court system includes civil courts, appeal courts, commercial courts, traffic courts, and an administrative court. Most of the judges are appointed by the ministry of justice, which is responsible for law enforcement. Most of the laws are based on the Napoleonic code (see Code Napoléon).

Local Government. The five largest towns in Egypt are ruled by urban governors. The rest of the country is divided into 15 provincial regions, each controlled by a ministry of interior. Mayors govern districts within the provinces of Egypt.

Politics. The only political party is the National Union party. All men over the age of 18 are required

Hubmann, Black Star

City Children may play in well-equipped schoolyards and parks. Some cities have supervised playgrounds. Child labor has been reduced, and modern schools provide free elementary and high-school education.

Country Children must work long hours in the farm fields to help their parents make a living. The children often play in the fields because the country villages usually lack parks or playgrounds.

by law to vote. Women were granted the right to vote for the first time in June, 1956.

National Defense. Egyptian law requires all men over 18 to serve in the armed forces. Men who have not had a high-school education must serve three years. High-school graduates spend only 18 months in service.

History

Ancient Egypt existed long before its history was written down. The recorded history of Egypt, which dates back to about 3100 B.C., is older than that of any other modern country. See EGYPT, ANCIENT, for the history of the country until A.D. 642.

The Middle Ages. In A.D. 639, troops from Arabia invaded Egypt under General Amr ibn-al-As (594?-664). In 642, Amr became the first Arab governor of Egypt. For the next 200 years, the *caliphs* (Moslem religious leaders) of the Persian provincial towns of Damascus or Baghdad appointed the governors of Egypt. During this period, the Arabs converted most Egyptians from the Coptic religion to Islam.

Two short-lived *dynasties* (families of rulers) governed Egypt during the 800's and 900's. In 969, the Fatimids from the Tunisian coast of North Africa invaded and conquered Egypt. The Fatimids ruled until 1171. During this period, Cairo became the center of the Moslem world. This was due partly to the founding of the University of Al-Azhar in Cairo about 970.

A young soldier named Saladin (1138-1193) seized the Egyptian throne in 1171 and founded the Ayoubid dynasty. He is probably the most famous Moslem ruler who fought against the Crusaders. See CRUSADES; SALADIN.

Saladin's family ruled until 1250, when the Mamelukes revolted and seized control of the country. The Mamelukes had been brought from Turkey to Egypt as slaves in the early 1200's. But they received special military training in Egypt and soon rose to positions of power and influence in the army and government. See MAMELUKE.

Turkish and French Control. The Mamelukes conquered Asia Minor, Syria, and Cyprus. But they failed to control discontent among the Egyptian people. The Mamelukes' power gradually weakened, and in 1517 the Turks conquered Egypt and added it to the Ottoman Empire. Turkish control over Egypt lasted until 1914. The Turkish rule was often very weak.

In 1798, French troops under Napoleon Bonaparte invaded Egypt to gain control of the land route to Great Britain's empire in India. Napoleon conquered Alex-

Authenticated News; Egyptian State Tourist Administration

Central Government Building in Liberation Square, named in memory of the 1952 revolution, gives Cairo an up-to-date look.

Egypt Honors Its Past Glories. The famous sculpture of Queen Nefertiti is used on a postage stamp issued by the country.

andria and won the Battle of the Pyramids in July. The British helped the Turks drive the French out of Egypt in 1801.

The 1800's. In 1805, the Turks appointed Mehemet Ali governor of Egypt. He built a sizable army and navy, organized state monopolies of trade, introduced cotton growing, and developed the irrigation system in the Nile delta. Ali also conquered the Sudan, just south of Egypt, in campaigns fought in 1820, 1822, and 1840.

A French firm, the Suez Canal Company, began to build the Suez Canal through the Sinai Peninsula in 1859, and finished the task 10 years later. The Egyptian government agreed to let the company operate the canal for 99 years. However, Egypt sold its shares in the company to Great Britain in 1875 when Ismail Pasha (1830-1895), head of the Egyptian government, went bankrupt because of his own extravagance. In this way, Britain obtained a large interest in the Suez Canal and a hold on the Egyptian government.

Egypt's financial condition became so bad in the late 1870's that the government appointed an Englishman, Sir Evelyn Baring, as minister of finance. In 1882, Egyptian nationalists led a revolt to free Egypt from foreigners in the government. British troops put down the revolt, and occupied the country.

In 1881, the Sudanese rose in revolt against Egypt because of heavy taxes and the slave trade. British and Egyptian troops under the command of Lord Kitchener defeated the Sudanese in 1898. Egypt and Great Britain agreed to make the Sudan a *condominium*, or protectorate jointly administered by the two countries. They named the region Anglo-Egyptian Sudan. See SUDAN.

Independence. Great Britain proclaimed a protectorate over Egypt in 1914. It increased the number of British troops in the country to defend the Suez Canal. Due to rising Egyptian nationalism, the British granted Egypt independence in 1922, with an agreement that British naval and military forces would remain stationed in the country. In 1936, according to the terms of a new Anglo-Egyptian agreement, British troops withdrew from posts in Egypt to the Suez Canal zone.

German and Italian troops invaded Egypt during World War II in an attempt to capture the canal. Sharp fighting took place between German and British troops from September, 1940, until November, 1942, when the British drove the Germans out of Egypt. In 1947, British forces, observing the 1936 agreement, again withdrew from Egypt to the Suez Canal zone.

Egypt became a charter member of the United Na-

RED-LETTER DATES IN EGYPT

(For events before A.D. 642, see EGYPT, ANCIENT.)

A.D. 642 The Arabs occupied Egypt.
969-1171 The Fatimid dynasty ruled Egypt and made Cairo the center of the Moslem world.
1171-1250 The Ayoubid dynasty ruled Egypt and fought the Crusaders.
1250-1517 The Mameluke dynasty ruled Egypt and conquered much land.
1517 Turkey invaded and conquered Egypt.
1798 Napoleon Bonaparte invaded Egypt.
1801 Great Britain helped the Turks drive the French out of Egypt.
1820-1840 Egypt conquered the Sudan.
1875 Great Britain bought a large controlling interest in the Suez Canal.
1882 Great Britain invaded and occupied Egypt.
1922 Egypt became independent of Great Britain.
1940 Germany and Italy invaded Egypt.
1948-1949 Egypt and other Arab League nations fought Israel.
1953 Egypt proclaimed itself a republic.
1955 The Sudan declared its independence.
1956 British troops evacuated the Suez Canal zone. Egypt seized the Suez Canal. Israel, Great Britain, and France invaded Egypt, but withdrew at the request of the United Nations.
1958 Egypt and Syria formed the United Arab Republic.
1961 Syria withdrew from the United Arab Republic.

tions in 1945. Also in that year, Egypt helped create the Arab League. When the United Nations decided to give part of Palestine to the Jews, the Arab League countries prepared for war. (See ARAB LEAGUE; PALESTINE.) Fighting began in May, 1948, and continued until Egypt and Israel signed an armistice in February, 1949. Egypt violated the armistice when it began blocking Israeli ships from the Suez Canal in 1950.

Republic. Egyptian nationalists staged bloody riots against the British in 1951 and 1952. In July, 1952, the Egyptian Army seized control of the government and drove pleasure-seeking King Faruk I from the throne.

Mohammed Naguib (1901-   ), commander in chief of Egypt's armed forces, made himself premier on Sept. 7, 1952. Two days later, the government passed the Agrarian Reform Law to help small farmers by giving them more land. In December, Naguib set up a council to create new industries and diversify agriculture.

Naguib's military council proclaimed Egypt a republic in June, 1953. It appointed Naguib as the country's first president. Naguib also remained premier.

Political Upheaval kept Egypt stirred up in 1954. Naguib fell from power, regained his position, then was ousted again in November by Gamal Abdel Nasser, deputy prime minister. Nasser took over the duties of president and premier.

Lengthy negotiations between Great Britain and Egypt over the British evacuation of the Suez Canal zone ended in October, 1954. The British agreed to remove all their troops by June 18, 1956. Egypt affirmed its support of freedom of navigation through the canal, but continued to block Israeli ships from the waterway.

Egyptian and Israeli troops clashed continually along the Gaza strip of northeastern Egypt in 1955. Anglo-Egyptian Sudan declared itself independent in December, 1955. Great Britain and Egypt had signed an agreement in 1953 giving the country three years to decide to be independent or to remain part of Egypt.

Nasser was elected president in June, 1956, and nationalized the Suez Canal on July 26. His action violated Egypt's agreement to let the Suez Canal Company operate the waterway. Nasser announced that profits from operating the canal would be used to build a new dam at Aswân. Earlier, the Americans and British had withdrawn offers to help pay for the dam.

Egyptian border raids on Israel provoked an invasion of Egypt by Israel on Oct. 29, 1956. Great Britain and France viewed the fighting as a threat to shipping on the Suez Canal. On October 31, British and French planes bombed Egyptian bases. Five days later, the British and French invaded Egypt in an effort to regain control of the Suez Canal. The United Nations arranged a cease-fire, and sent a 16-nation police force to the Suez Canal to maintain peace. The last British and French troops left Egypt in December, 1956. All Israeli troops were withdrawn by March, 1957.

United Arab Republic. In 1958, Egypt and Syria gave up their national sovereignty to form a new nation, the United Arab Republic. Yemen then federated with the U.A.R. to form the United Arab States. Gamal Nasser was elected as the first president of the U.A.R. In October, 1958, Nasser announced the reorganization of the United Arab Republic. Separate ministries for Egypt and Syria were abolished, and a central ministry was set up in Cairo.

In 1959, the United Arab Republic resumed trade relations with Great Britain and France. Relations had been broken with these countries since 1956, when the fighting broke out over the Suez Canal. In 1961, Egyptian exports exceeded imports for the first time. New industries started during the 1950's had turned Egypt into an important manufacturing nation.

Recent Events. In September, 1961, Syrian army units overthrew their government and Syria withdrew from the United Arab Republic. In December the same year, Nasser dissolved the United Arab States and his country's federation with Yemen. GEORGE H. T. KIMBLE

Related Articles in WORLD BOOK include:

Biographies

An alphabetical list of biographies relating to Egypt appears under the heading Egypt in the BIOGRAPHY section of the READING AND STUDY GUIDE.

Cities

Alexandria
Aswân
Asyût
Cairo
El Alamein
El Minya
Gaza
Port Said
Suez

History

Arab League
Egypt, Ancient
Israel (History)
Khedive
Mameluke
Middle East
Nasser, Gamal A.
Pyramids
Sudan (History)
Suez Canal
Syria
United Arab Republic
Valley of the Kings

Physical Features

Arabian Desert
Libyan Desert
Nile River
Oasis
Qattara Depression
Red Sea
Sahara

Unclassified

Asp
Copts
Cotton
Ichneumon
Irrigation
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Sphinx

Outline

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Questions

How does Egypt differ from most countries in the distribution of its people?

What is the *khamsin*?

What is Egypt's most important crop? What event in United States history affected this crop in Egypt?

How does education affect service in the armed forces?

In what ways do the three main groups of Egyptians differ from each other?

What country gave Egypt its independence in 1922?

What is the chief occupation of Egyptians? How does it compare to the same occupation in your state or province?

What is Al-Azhar? Why is it important?

How did Britain gain control of the Suez Canal zone?

What tourist attractions does Egypt have?

ANCIENT

A Gold Mask of King Tutankhamon covered the face of his mummy. Archaeologists discovered the mask when they opened the tomb of "King Tut" in 1922. They found in it many other beautiful treasures. The mask is now in the Egyptian Museum, Cairo, Egypt.

EGYPT, ANCIENT. The giant pyramids, temples, and tombs of ancient Egypt tell an exciting story about a great nation that rose to power more than 5,000 years ago. This mighty civilization crumbled before conquering armies after 2,500 years of triumph and glory. The dry air and drifting desert sands have preserved many records of ancient Egypt until modern times.

The ancient Egyptians lived colorful, active, and eventful lives. Many were creative artists, inventive scientists, and adventurous explorers. Bold Egyptian warriors won many battles, and their rulers governed wide areas of the known world. The ancient Egyptians loved nature and had a lively sense of humor. They were among the first peoples to try to find answers to questions concerning man, nature, and God. They also considered the relationship of man to society. But they regarded other peoples as savages. They captured and enslaved thousands of persons from other lands.

The Greek historian Herodotus called Egypt "the gift of the Nile," because floodwaters of this great river deposited rich, black soil on the land year after year. Egyptian farmers planted their crops in this fertile soil. Sandy plateaus and towering cliffs bordered the river valley. Beyond stretched the barren wastes of the Sahara desert. On the edge of the desert, the Egyptians built giant pyramids as burial places for their pharaohs (rulers). They carved the Great Sphinx out of solid rock near their temples and tombs.

The ancient Egyptians called their country *Kemet*, which means *black* (after the land). The Greeks called the country *Aigyptos*, from the name *Ha(t)-ka-ptah*, the main temple of the Egyptian capital at Memphis.

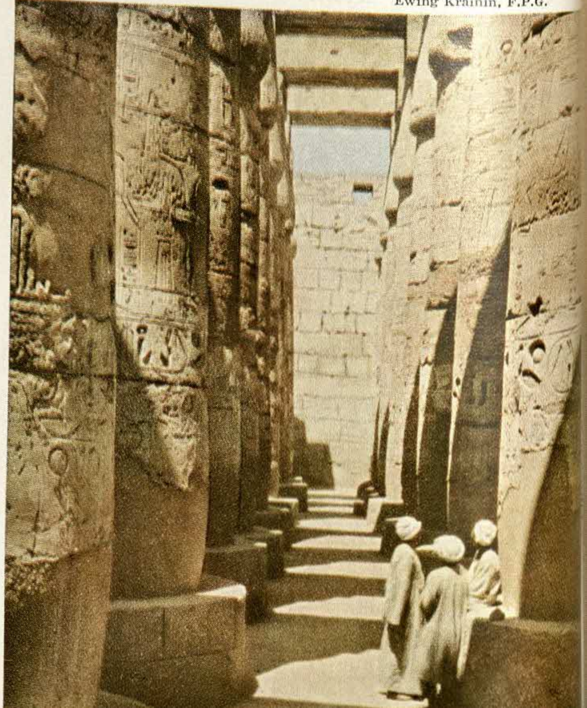
Many modern beliefs and ideals, as well as much of man's knowledge, had their origin in Egypt. The ancient Egyptians developed the world's first national government. Their religion was the first to emphasize a life after death. They produced an expressive art and literature. The Egyptians introduced stone architecture and made the first convenient writing material, *papyrus*. They developed a 365-day year and set up the basic methods of geometry and surgery.

The Land and Its Resources

Location and Size. The boundaries of ancient Egypt changed many times during its history. When the kingdom of Egypt was formed about 3100 B.C., it occupied only the fertile valley of the Nile River in northeastern Africa. The kingdom extended south about 500 miles from the Mediterranean Sea to the First Cataract (waterfall) of the river. It averaged only about 12 miles in width from the Nile delta to the First Cataract. Egypt covered about 8,000 square miles, and was a little smaller than the state of Massachusetts.

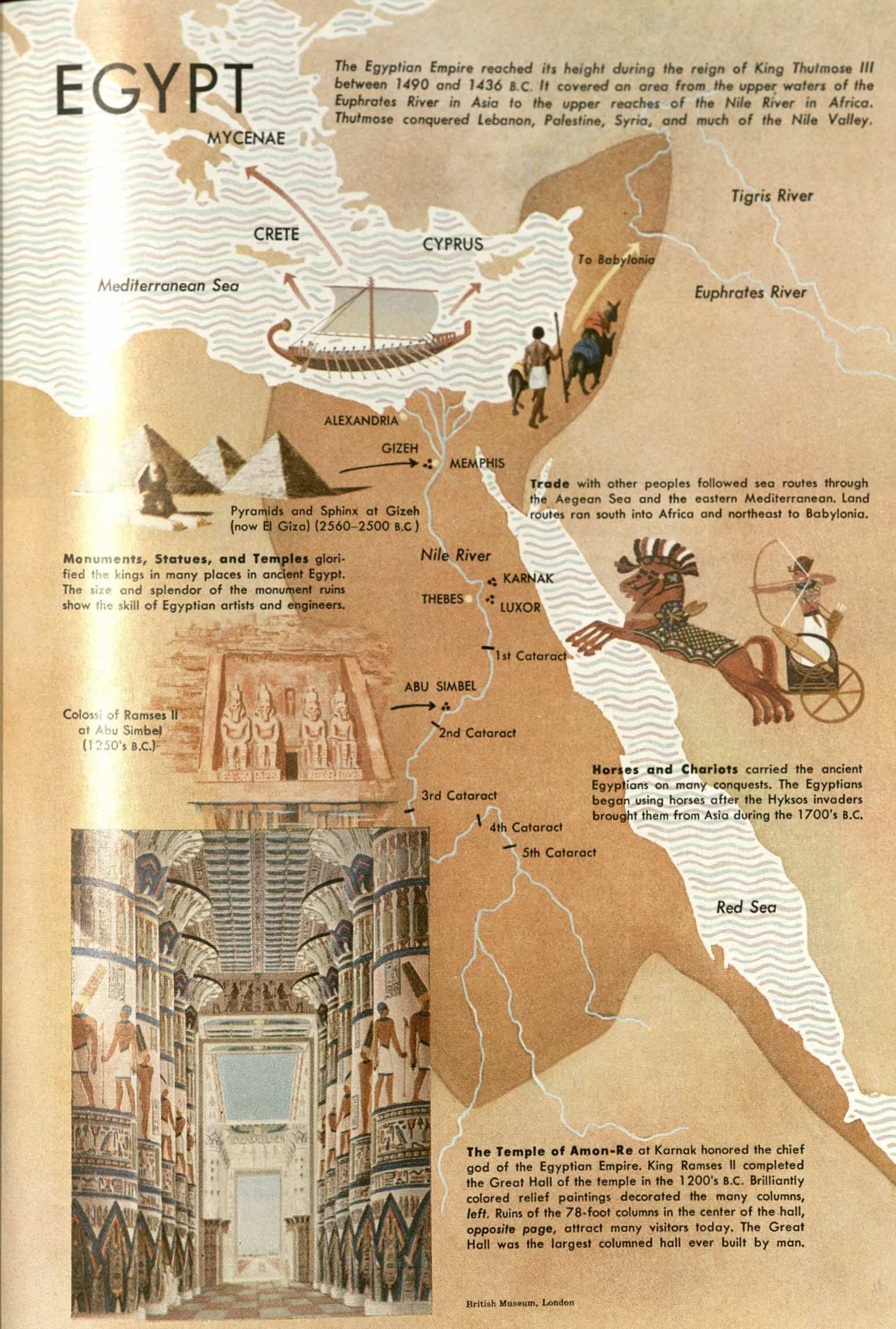
In later years, ancient Egypt usually controlled neighboring areas around the Nile Valley. Sometimes it ruled oases, or fertile green patches, in the desert to the west. It usually governed part of the Nile Valley south of the First Cataract, the Red Sea coast, and the western part of the Sinai Peninsula in Asia. At the height of its power, about 1450 B.C., Egypt claimed an empire that reached as far south as the Fourth Cataract in Nubia, a part of ancient Ethiopia, and as far northeast as the Euphrates River in western Asia.

Ewing Krainin, F.P.G.



EGYPT

The Egyptian Empire reached its height during the reign of King Thutmose III between 1490 and 1436 B.C. It covered an area from the upper waters of the Euphrates River in Asia to the upper reaches of the Nile River in Africa. Thutmose conquered Lebanon, Palestine, Syria, and much of the Nile Valley.



Pyramids and Sphinx at Gizeh (now El Giza) (2560–2500 B.C.)

Monuments, Statues, and Temples glorified the kings in many places in ancient Egypt. The size and splendor of the monument ruins show the skill of Egyptian artists and engineers.

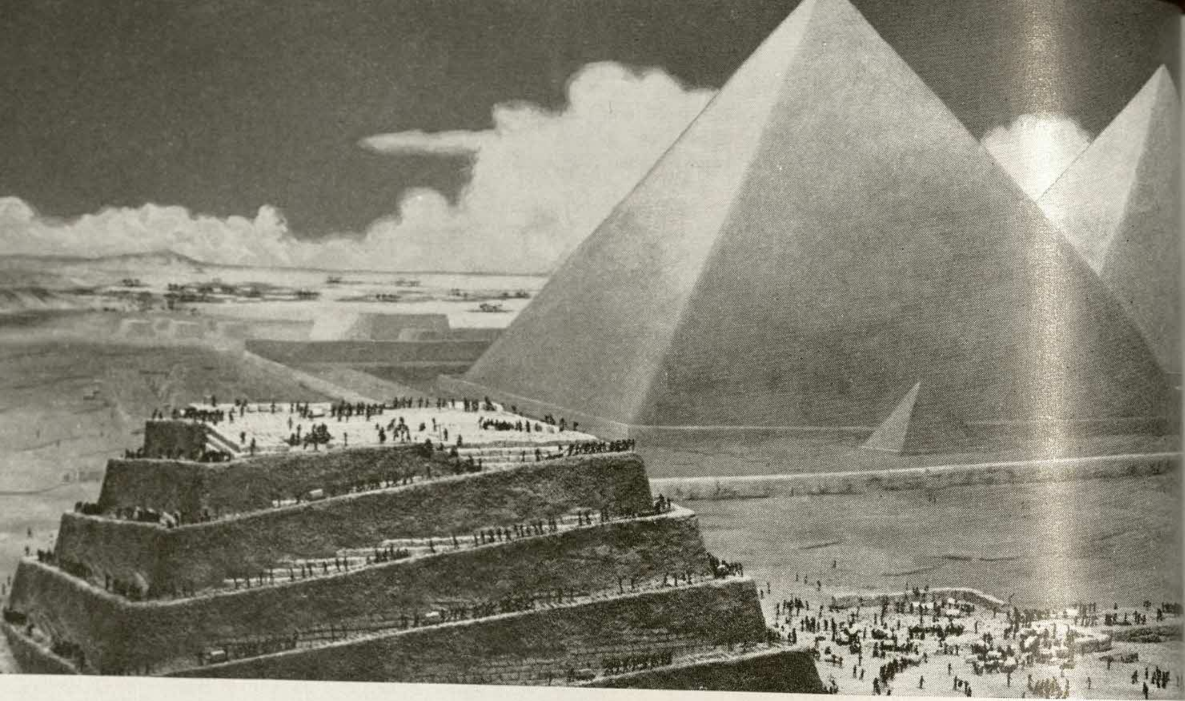
Colossi of Ramses II at Abu Simbel (1250's B.C.)

Trade with other peoples followed sea routes through the Aegean Sea and the eastern Mediterranean. Land routes ran south into Africa and northeast to Babylonia.

Horses and Chariots carried the ancient Egyptians on many conquests. The Egyptians began using horses after the Hyksos invaders brought them from Asia during the 1700's B.C.

The Temple of Amon-Re at Karnak honored the chief god of the Egyptian Empire. King Ramses II completed the Great Hall of the temple in the 1200's B.C. Brilliantly colored relief paintings decorated the many columns, *left.* Ruins of the 78-foot columns in the center of the hall, *opposite page,* attract many visitors today. The Great Hall was the largest columned hall ever built by man.

British Museum, London



Museum of Science, Boston

A Great Engineering Feat . . . . BUILDING THE PYRAMIDS

Thousands of Workers toiled for years to build the pyramids as tombs for kings. No record of their methods has been found, but Boston's Museum of Science made a scale model showing one possibility. The model, *above*, shows the pyramid of King Menkaure nearing completion about 2525 B.C. The pyramids of two earlier Egyptian kings, Khafre and Khufu, tower in the background.

Natural Resources. The black soil that the flooding Nile left behind every year gave the Egyptians rich farm land. The Nile delta contained large beds of salt. Near the First Cataract, the Egyptians mined granite and sandstone. In the desert and hills to the east lay deposits of copper, manganese, and turquoise. The Egyptians also mined beryl, gold, gypsum, and phosphate. No forests thrived in the Nile Valley.

Climate. Throughout Egypt's long history, the country has had about the same dry climate. Almost no rain falls. The dry land depends on the annual summer floods of the Nile River for water. The floods begin about June and end in October. There would be no Egypt without the river, because its waters carry rich silt that makes the fields fertile. The ancient Egyptians built catch-basins to trap the water over the soil. They used it to irrigate the fields. The basins allowed silt to settle and enrich the soil.

Life of the People

The People. Ancient Egypt was much less crowded than modern Egypt. Historians believe that from 1,000,000 to 8,000,000 persons lived in ancient Egypt. In Roman times, estimates set the figure at about 6,000,000. Most Egyptians lived near the Nile, with an average of 750 persons to the square mile. Today, the valley averages about 1,200 persons to the square mile, although Egypt as a whole averages only 49.2.

The black-haired, dark-skinned ancient Egyptians were short and slender. They belonged to the Mediterranean race of the Caucasoid (white) stock. As time went on, the Egyptians mixed with peoples from Asia, Negroes from other parts of Africa, and peoples from lands around the Mediterranean Sea.

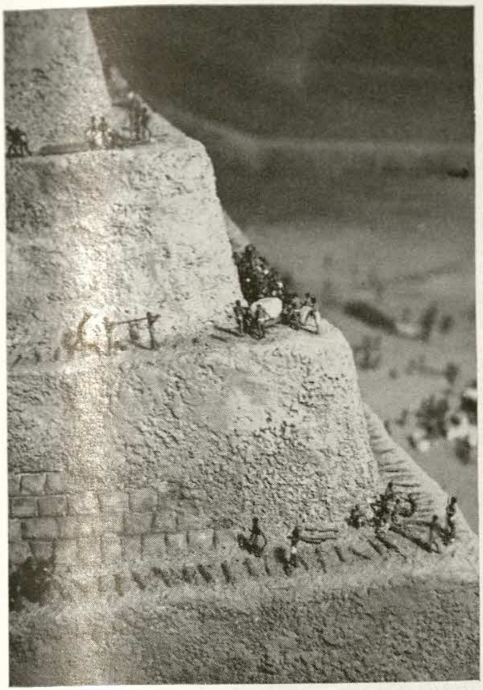
The Egyptians were divided into four social classes: (1) the royalty and nobles; (2) artisans, craftsmen, and merchants; (3) workers; and (4) slaves. The professional army gradually became almost a separate class. Egypt had no fixed caste system. A person of the poorest class could rise to the highest offices in the land.

Language. The ancient Egyptians spoke a mixed language. It included words from the *Semitic* language group of southwestern Asia and the *Hamitic* group of languages of northeastern Africa. The language died out of everyday use about 1,000 years ago, but the Coptic (Christian) Church still uses it (see COPTS).

Historians do not know exactly how the language sounded as the ancient Egyptians spoke it. Their alphabet had 24 symbols for consonants, semi-consonants, and some guttural sounds not found in the English language. They did not write vowels. In Egyptian, the word *pharaoh* originally meant *great house*. In the late 1300's B.C., it came to mean *ruler of Egypt*.

The Egyptians developed picture writing into an elaborate system of symbols (see HIEROGLYPHIC). Later, they devised a script form of hieroglyphic called *hieratic*. The Egyptians called their writing "the words of the god," and claimed that one of their gods, Thoth, had invented it (see THOTH). But hieroglyphic was not suited to everyday purposes. It had to be carved or painted on a stone wall or on writing tablets, and tablets were hard to carry about. The Egyptians found that they could use hieratic to write rapidly on leather or papyrus that was easy to carry (see PAPYRUS). Modern scholars first learned to read hieroglyphic when they translated the writings on the Rosetta Stone (see ROSETTA STONE).

Family Life. The Egyptians were a family-loving



Museum of Science, Boston, Photos courtesy Boston Museum of Fine Arts

→

Layers of Blocks gradually built up the pyramid. Workmen placed a granite capstone at the top. The four outer faces of the pyramid then resembled a series of steps. While workmen removed the ramps, they also smoothed and finished the outer casing.

Ramps sloped upward around the sides of the pyramid. Each ramp could be extended at the top. Workmen hauled sledges to drag 5,000-lb. blocks up the ramps. They used levers to ease the blocks around corners. They laid timbers on the ramps to reduce the friction of the sledges.

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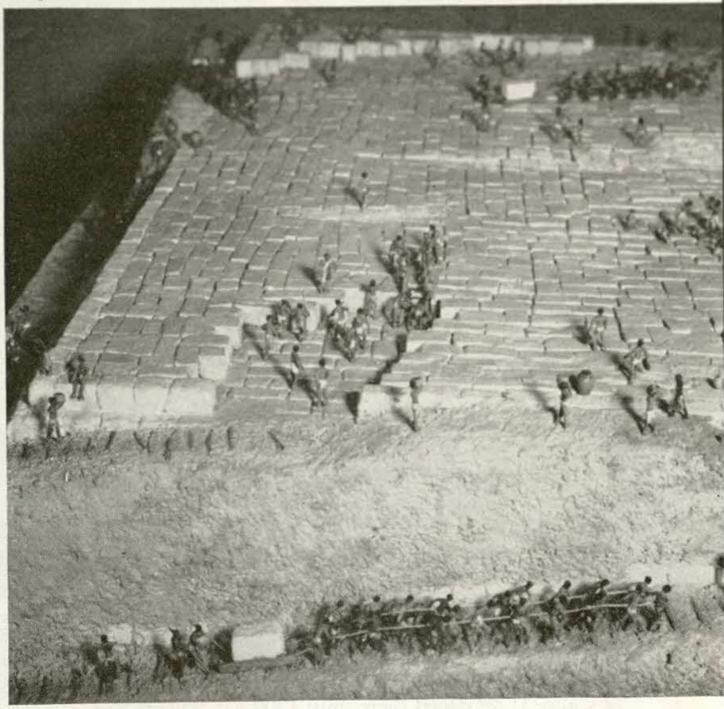


people. They had great affection for children. In the earliest times, the husband ruled the family, but women later gained equal rank. Women had the right to own property and could buy and sell goods. The eldest son usually inherited the largest share of his father's estate. Daughters could also inherit property. Sons were responsible for the care of their fathers' tombs. Egyptian custom allowed a husband to have a number of wives, and a boy to marry his sister, although few did so.

Shelter. Most people of ancient Egypt were poor, and lived in simple houses. Only rich persons, such as members of the ruling class, could afford better homes. Houses faced north to catch the cooling wind.

The poorest Egyptians probably lived in small huts of mud or sun-dried brick, covered with palm leaves or straw. Beams of palm trunks supported the flat roofs. The Egyptians built their houses in the shape of small squares or oblongs around open courts. They divided their buildings into small cell-like rooms. For windows, they cut small slits high in the walls, because larger windows would let in the intense, dry heat. An outside stairway led to the roof, where the family usually slept.

An Egyptian's furniture included a stool, some boxes, and a few pottery jars. People cooked in clay ovens or over open fires in the courtyards, using charcoal or wood.

Wealthy Egyptians built beautiful, spacious homes of brick and wood. They draped brightly colored hangings over latticed windows. Luxurious furnishings, such as rugs, ebony chests, and vessels of copper and gold, decorated the homes. Gardens and orchards surrounded almost all the houses.

Food. The regular diet for most Egyptians consisted of barley bread, fish, vegetables, and beer. On some holidays, they might enjoy fruit, meat, and wine. Beer was ancient Egypt's most popular beverage. Egyptian women ground grain into a coarse meal between two stones, and used the meal to make bread. Sometimes they flavored the loaves with sesame seeds.

Wealthy Egyptians ate beef, veal, antelope and gazelle meat, fruits, honeyed sweetmeats, and several kinds of bread and cakes. They often gave lavish banquets and feasts.

Clothing. Fashions in Egypt remained in style for hundreds of years. At first, men wore only the *shenti*, a loincloth of white cotton or linen. Later, they wore longer loincloths that became skirts or aprons. A man wore his loincloth tight across his back and gathered it in pleats in front. The pleats fell away from the center of the garment in slanting lines. Wealthier Egyptians added a transparent shirt or coat to this costume. Sometimes they wore shawls or capes over their shoulders.

Egyptian women wore tight, straight dresses with shoulder straps. These garments reached from the bosom to the ankles. Later, the women added colorful cloaks with embroidered hems. They blackened their eyebrows and outlined their eyes with green paint. They colored their lips red, and used henna to dye their fingernails yellow or orange.

Persons who could afford them wore wide, round collars of jewels or beads. They decorated their wrists and upper arms with beautiful rings and gay bracelets.

Both for beauty and for protection against the heat, wealthy Egyptians wore long, heavy black wigs of sheep's wool or human hair. Sometimes they wore striped or embroidered headdresses. The elaborate head ornament and crown signified the wearer's social standing. Even the Great Sphinx wears such a headdress (see SPHINX).

Recreation. The fun-loving Egyptians enjoyed games, hunting, fishing, and athletic contests. They celebrated on important occasions by making offerings and sacrifices to their gods. In their homes, Egyptians often played *senit*, a game that resembles backgammon. They often hired wrestlers to stage contests. Riding in horse-drawn chariots became popular after about 1500 B.C.

Ancient Egypt's dances came from the working people. But the people did not dance merely for pleasure, as people do today. The Egyptians believed that their gods danced. Magic and religion inspired the early dances, and often the priests performed them (see DANCING [Development]).

City Life. The ancient Egyptians built most of their towns and cities along the banks of the Nile. The most important cities served as capitals, as centers of worship, or as burial places for royalty and nobles. Today these cities lie buried under modern villages.

Memphis and Thebes were the principal capitals of ancient Egypt. Memphis served as the first center of the Egyptian government. According to tradition, King Menes founded the city in 3100 B.C. Its ruins lie 12 miles south of Cairo. About 2100 B.C., the Egyptians moved their capital to Thebes, some 400 miles south of Cairo. It remained there until 1300 B.C. Thebes had a burial ground on the west bank called the Valley of the Tombs of the Kings (see VALLEY OF THE KINGS). In 1922, archaeologists found the treasure-filled tomb of King Tutankhamon in the valley (see TUTANKHAMON). The tomb was the first to be found that robbers had not broken open and looted.

The rulers of ancient Egypt built huge temples and elaborate palaces in the centers of their cities. Workers grouped their small mud-brick huts around the government buildings. The people crowded their huts so closely together that often the walls touched. Dusty streets separated the groups of huts. The Egyptian government built barracks, or long rows of small mud-brick rooms under a single roof, as living quarters for people working on government construction projects. Wealthy citizens often built large country estates on the outskirts of the towns.

The Metropolitan Museum of Art, New York

Cats were considered sacred in ancient Egypt. The Egyptians built stone temples for their cats. They buried many cats in gold coffins. An Egyptian artist made this bronze statuette around 200 B.C.

Work of the People

Most ancient Egyptians made their living from farming. Some worked in the mines and quarries, and others were traders or soldiers. Factories were few and small.

Agriculture. Egyptian farmers plowed and seeded the fertile fields as soon as the floodwaters of the Nile went down. In the warm climate, farmers could grow two or three crops a year. They used long-horned oxen to pull their plows, and chopped weeds with wooden hoes. A farmer might plant barley, flax, and a kind of wheat called *emmer*. He raised such vegetables as beans, cabbages, cucumbers, lettuce, peas, and radishes. He also grew melons and fruits.

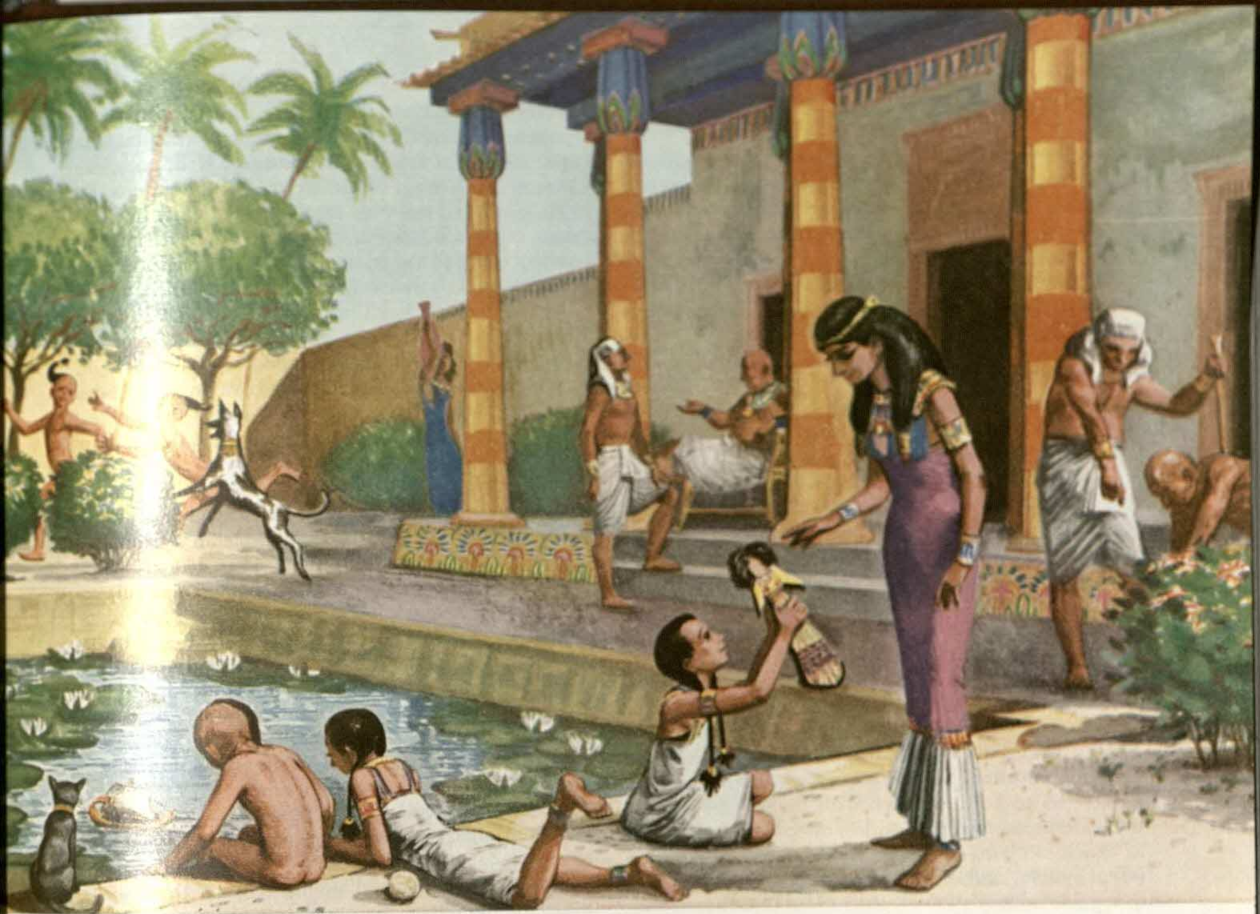
The Bible tells how Joseph, an Israelite slave, proposed the idea of storing Egyptian grain and other crops for use in times of famine (see JOSEPH). Many Egyptian families had cattle, donkeys, ducks, geese, goats, and sheep. Farmers used dogs to help tend the flocks. The Hyksos introduced horses into Egypt about 1700 B.C. (see HYKSOS).

Manufacturing. Single craftsmen usually operated ancient Egypt's small manufacturing shops. A village community usually included a coppersmith, a potter, a jeweler for the wealthy, a craftsman who made charms for the poorer folk, and a family who wove cloth. Villages close to the Nile River usually had a shipyard. Shops in a group of neighboring villages made everything the people needed except metals.

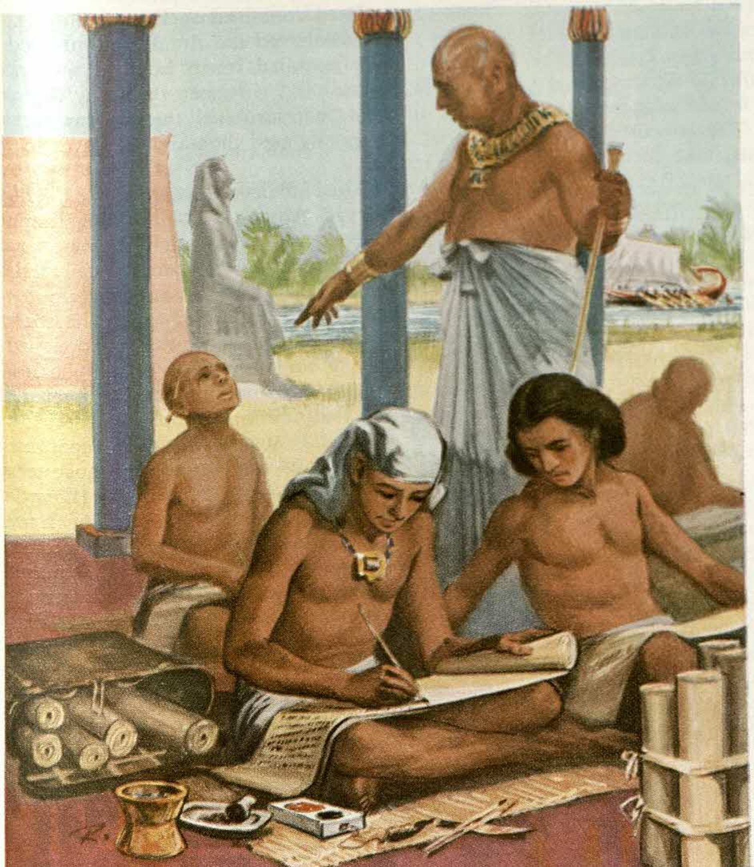
Some historians believe that the Egyptians invented glass and glaze. Egypt was the center of glass manufacturing from about 1500 B.C. to about 300 B.C. (see GLASS [Early Times]). The Egyptians also made the world's first convenient writing material by using strips of the stems of papyrus plants to make a kind of paper (see PAPER [History]).

Mining. Before 3100 B.C., the Egyptians began mining and smelting copper from the Sinai desert. They made bronze by melting copper and tin together. The Egyptians dug rich deposits of gold from the hills east of the Nile. When the empire extended south into Nubia, the Egyptians took gold from the mines there. They quarried granite and limestone in the mountains near the Red Sea coast. They also mined amethyst, beryl, malachite, and turquoise. But the Egyptians had no sources of silver or iron. They had to import iron from Asia, beginning around 1300 B.C. Some scholars believe they imported silver from the Hittites.

Trade and Transportation. Egyptian ships sailed to many ports of the civilized world, both as peaceful traders and as conquerors. They traveled northwest into ports in the Aegean Sea, and northeast to Palestine, Phoenicia, Syria, and the land of the Hittites in Asia. To the south, they traded with peoples along the eastern coast of Africa. According to tradition, the Egyptians dug a canal to link the eastern part of the Nile delta



An Egyptian Country Estate often had a shallow lotus pool enclosed in a courtyard. The pool served as a decoration, but was also stocked with fish. Although they had gardens, the Egyptians did not grow grass. Wealthy families owned at least one greyhound and several cats. Girls played with dolls, and often wore their hair in "pigtails." Egyptian boys had their heads shaved, except for a braided lock on one side.



A School for Scribes taught boys how to write on papyrus scrolls with brushes. A scribe used a palette to hold paints and tied a piece of cloth to it for use as an eraser. He prepared paint to write with by grinding pigments on a stone slab and mixing them with water from a bronze basin. Boys who finished school became clerks, letter writers, or paymasters in the government.

with the Red Sea as early as the 1900's B.C. Some historians believe that the Egyptians were the first people to sail the dangerous Cape of Good Hope route around the southern tip of Africa. Egyptian caravans made many expeditions to Sudan.

The ancient Egyptians traded by *bartering*, or exchanging goods for other goods. They bartered their copper, grain, linen, papyrus, and fine-grained stones for woods such as cedar, cypress, fir, and pine from Lebanon. They also bartered for gold, hides, ivory, ostrich feathers, and tropical woods in Punt, in central Africa. Farmers often traded their barley and flax locally for small manufactured goods, such as magical charms, metal knives, sandals, and storage pots. The Egyptians did not use coins until about 300 B.C.

Galley ships and sailing vessels carried passengers and cargoes. The Egyptians made small boats from their limited supply of wood. They made seagoing vessels from cedar and fir imported from Asia.

Attendants at the royal court carried nobles and members of the royal family from place to place in sedan chairs. After the Egyptians began using horses, about 1700 B.C., they traveled in chariots. Donkey caravans carried people and goods in the desert regions. The Egyptians did not use camels until about 500 B.C.

Communication. The Egyptian government used messengers to keep in touch with the distant parts of the widespread empire. Couriers often took three weeks to reach outlying districts. The government had a postal system, and official postmen delivered messages at regular hours.

Activities of the People

Education. Most Egyptian boys learned their work from their fathers, or as apprentices in various trades. Boys of royal and wealthy families were trained to become priests or government officials. At the age of 5, they were placed in the schools for scribes at the capital. Priests controlled the schools. They required the students to memorize classic texts, take dictation, and learn to use about 700 characters of the Egyptian language. They also taught literature. Schoolboys practiced their writing by copying stories and proverbs. Archaeologists have found copybooks that these boys used for practicing their handwriting.

After 1400 B.C., the government needed additional clerks, and allowed more boys to go to school to be trained for government service. But the number of persons who could read and write remained small.

Religion appeared in every part of life in ancient Egypt. It included much of what people today would call superstition. The Egyptians believed that gods and goddesses took part in every human activity from birth to death. For the Egyptian, the good life depended on obeying the commands of the gods. After a person died, the gods would judge how well he had obeyed their directions. The Egyptians were the only ancient people who believed that their king was a god who could keep the country prosperous by his divine powers.

In the earliest period, the Egyptians worshiped the forces of nature, such as wind and water. As towns grew up, each adopted its own special god. In one part of the delta, the people worshiped Horus, the god of heaven (see HORUS). In another district, the people worshiped Osiris, the god of vegetation, who later became the god of the dead (see OSIRIS). Heliopolis, near Cairo, was the center for the worship of the sun god Re, or Ra (see RE). Heliopolis means *city of the sun* in Greek. About 2500 B.C., priests at Heliopolis developed the worship of Re as the nation's first state religion. Other members of Re's divine family included Osiris and his wife, Isis; Seth, the evil brother of Osiris, and his wife Nephthys; Shu, god of air; Tefnut, goddess of moisture; Geb, god of earth; and Nut, goddess of the sky.

The people of Thebes worshiped Amon, or Ammon, the god of wind. When Thebes became the political center of the empire, the people worshiped Amon and Re together as Amon-Re (see AMON).

The Egyptians believed that certain animals might serve individual gods in a special way. For example, they regarded the ram as acceptable to Amon, and chose one ram to be the temple animal of that god. Other sacred animals included the baboon, bull, cat, crocodile, and jackal.

The people of ancient Egypt took great care in preparing for life after death. They denied that death ended the existence of a person who had led a good life. They believed that the next world would be like Egypt in its richest and most enjoyable form. They built stone tombs and filled them with clothing, food, furnishings, and jewelry for use in the next world. They embalmed their dead and wrapped the bodies in layers of cloth. Preserved bodies were called *mummies* (see EMBALMING; MUMMY).

The Egyptians carved inscriptions on the walls of some tombs. Later, they wrote on the insides of the coffins. They placed papyrus copies of the *Book of the Dead* in the tombs to protect the spirits of the dead. The Book of the Dead contained spells and prayers.

The priests conducted the rituals and guarded the temples. They acquired much political power. For example, the king did not make them pay the *corvée*, a tax in labor that furnished the government with workers. The priests used thousands of slaves to work in the temples.

The Arts reached full development early in the history of ancient Egypt. All the arts, including literature, served a religious purpose. Egyptian literature covered a wide range of subjects, from hymns to fairy tales.

The Egyptians planned their architecture to last forever. Their greatest achievement was the construction of the pyramids (see PYRAMIDS). They designed the solid masonry of these structures to emphasize the belief that a person does not die, but lives forever. The Egyptians also built towering temples with thick walls that sloped in gently toward the top. Important examples of such architecture include the huge temples at Karnak and Luxor (see ARCHITECTURE [Egyptian]).

Painting and sculpture in Egypt went through several phases. The earliest paintings and relief sculptures had a flattened appearance, and statues had a squared-off look. The artists believed that this solid, permanent feeling in their painting and sculpture portrayed dignity. Egyptian sculptors almost never made statues that stood alone, but planned each statue as a definite part of a palace or temple (see MEMNON [picture, Two Huge Statues]).

Artistic, political, and religious developments of the late 1300's B.C. brought a new type of Egyptian art. Artists broke with tradition. They created works with more liveliness and naturalism. About 700 B.C., artists returned to the style of the earlier period and copied it (see PAINTING [Ancient]; SCULPTURE [History]).

The Egyptians played many musical instruments, including clarinets, drums, harps, and lutes. Historians believe that they used instruments only to accompany singers or dancers.

The Sciences. Egyptian discoveries in mathematics and other sciences became the foundations of some of man's greatest achievements in those fields. The Egyptians used a system of counting by tens, but their system had no zeros. They could multiply and divide whole numbers, and reduce simple fractions. They used a series of simple fractions, such as $\frac{1}{2}$, $\frac{1}{5}$, and $\frac{1}{10}$, to build up complex ones, such as $\frac{4}{5}$. The Egyptians could determine areas and calculate the volumes of objects. They were the first people to survey land. The floodwaters of the Nile washed away the boundaries of farms every year, and new ones had to be fixed by surveying. The Egyptians measured distances accurately with equally spaced knots tied in long ropes. They used a *cubit*, the length of a man's forearm, as a standard of measurement (see CUBIT). They worked out the foundations of geometry and algebra.

By applying mathematical principles, the Egyptians built their pyramids with remarkable exactness. The Great Pyramid at Gizeh (now El Gîza) contained about 2,300,000 stone blocks. Each block weighed about 5,000 pounds. Workmen shaped each stone so carefully that the blocks fitted together within hundredths of an inch.

The Egyptians also pioneered in the field of astronomy. They distinguished between planets and stars, and devised a 365-day calendar (see CALENDAR).

In medicine and surgery, the Egyptians recognized the importance of the heart and its relation to other parts of the body. They related the speed of a person's heartbeat to his general physical condition. The Egyptians also knew how to sew up wounds.

Government

The ancient Egyptians believed that their king was a god. As such, he was an absolute ruler. Ancient Egypt was always a *theocracy*, or a government of priests. Almost no distinction was made between priests and government officials. The king's officials served as his deputies in carrying out his divine commands.

The government's highest officials included the *vizier*, or prime minister, the chief treasurer, the chief tax collector, the minister of public works, and the army commander. Each was responsible to the king.

Egypt was divided into *nomes*, or provinces. By about 1300 B.C., there were 42 nomes. The king appointed the governor of each nome. Mayors governed the villages and were responsible to the vizier.

The king and the highest officials owned much of the land. The government collected a tax paid in goods. It also levied a *corvée*, or a tax paid in labor, to provide soldiers and government workers.

Galley ships rowed by forced labor made up the Egyptian fleet. The government drafted men for the army. Soldiers served during the wet season, and then returned to their homes. As the empire grew, the king hired *mercenaries*, or professional soldiers from other lands. In time of war, the militia of each province served with the king's army. The Egyptians also used slaves to fight in the army.

History

Early Days. Egypt did not develop as a nation until about 3100 B.C. Earlier, Egypt had been divided into small states that finally combined into two large ones. One of the two states, *Upper Egypt*, included territory south of the delta on the two banks of the Nile. The other state, *Lower Egypt*, occupied the delta, much of it swamp land. Some historians believe that a king named Menes came to the throne in Upper Egypt about 3100 B.C. He conquered Lower Egypt and formed a united kingdom with the capital at Memphis. Menes is usually considered the founder of the first dynasty. Even after the two separate states became united, the people still called their country *the Two Lands*.

Menes' dynasty and the one that followed ruled Egypt for about 400 years. During this period, the Egyptians developed a national government and began to use writing. They devised a new style of architecture. Egyptian farmers probably learned to irrigate their fields and to use the plow during this time. Craftsmen fashioned axes, knives, and other metal tools.

The Old Kingdom (2700-2200 B.C.). During this 500-year period, often called *the Age of the Pyramids*, the kings were dictators with total powers of government. The Egyptians achieved their greatest accomplishments in art and architecture. They completed more than 20 major pyramids. The pyramid designed by Imhotep is the oldest known stone structure in the world. Imhotep was also a skilled physician. The people later called him a god of medicine.

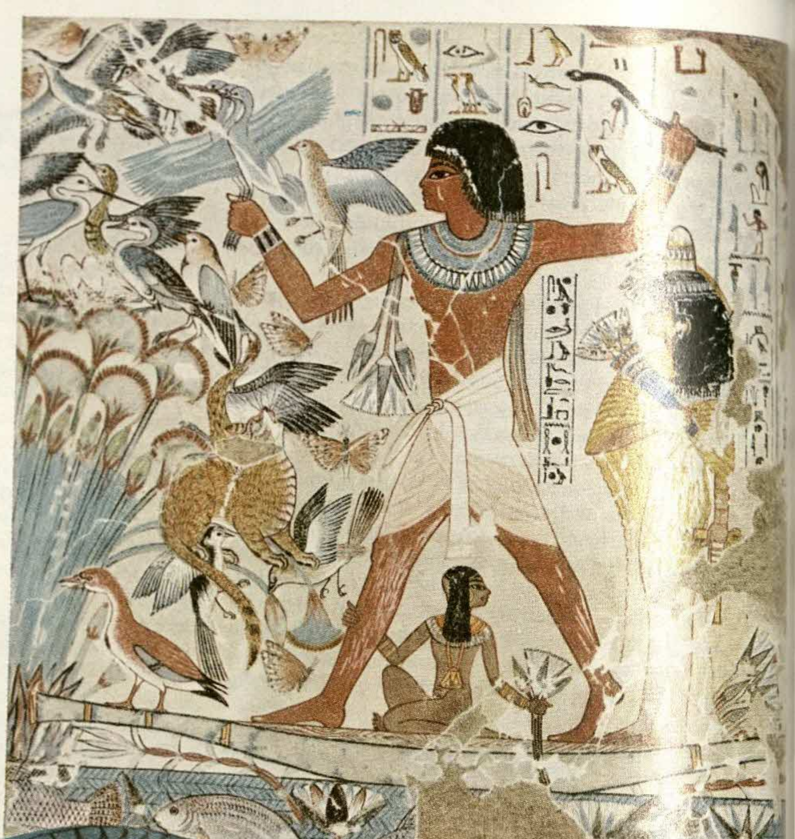
The Egyptians built three gigantic pyramids at Gizeh (now El Gîza), north of the capital city of Memphis, for the god-kings. King Khufu constructed the largest of these pyramids (see KHUFU). The government required all able-bodied men to work on the pyramids for several months every year.

RED-LETTER DATES IN EGYPTIAN HISTORY

3100 B.C. King Menes united the separate kingdoms of Lower and Upper Egypt.
2700-2200 B.C. Egyptian art and architecture developed to their highest point during the Old Kingdom.
2200-2050 B.C. Several families fought to rule Egypt.
2050-1800 B.C. A family of rulers from Thebes reunited Egypt as a feudal state.
1800-1570 B.C. Several weak kings ruled Egypt, and the Hyksos from Asia overran the country.
1490-1436 B.C. The Egyptian Empire reached its height during the reign of King Thutmose III.
1370-1350 B.C. King Akhenaton brought sweeping artistic, political, religious, and social changes.
1090-945 B.C. The priests and nobles struggled for royal power, and left Egypt broken into small states.
945 B.C. Sheshonk I seized the Egyptian throne and founded a dynasty of Libyan rulers in Egypt.
720 B.C. Piankhi overthrew the Libyans and began a period of Sudanese rule over Egypt.
670 B.C. The Assyrians conquered Egypt.
525 B.C. The Persians conquered Egypt.
332 B.C. Alexander the Great added Egypt to his empire.
306 B.C. Ptolemy I became King of Egypt.
30 B.C. Roman armies conquered Egypt.
A.D. 642 The Arabs completed their conquest of Egypt.

LIFE ALONG THE NILE

Hunting and Fishing provided the Egyptians with food and recreation. A painting found in a tomb made around 1400 B.C. shows an Egyptian nobleman and his family on a boat trip in the marshes along the Nile. The nobleman uses a snake-shaped throw stick, like a boomerang, to knock down water birds.

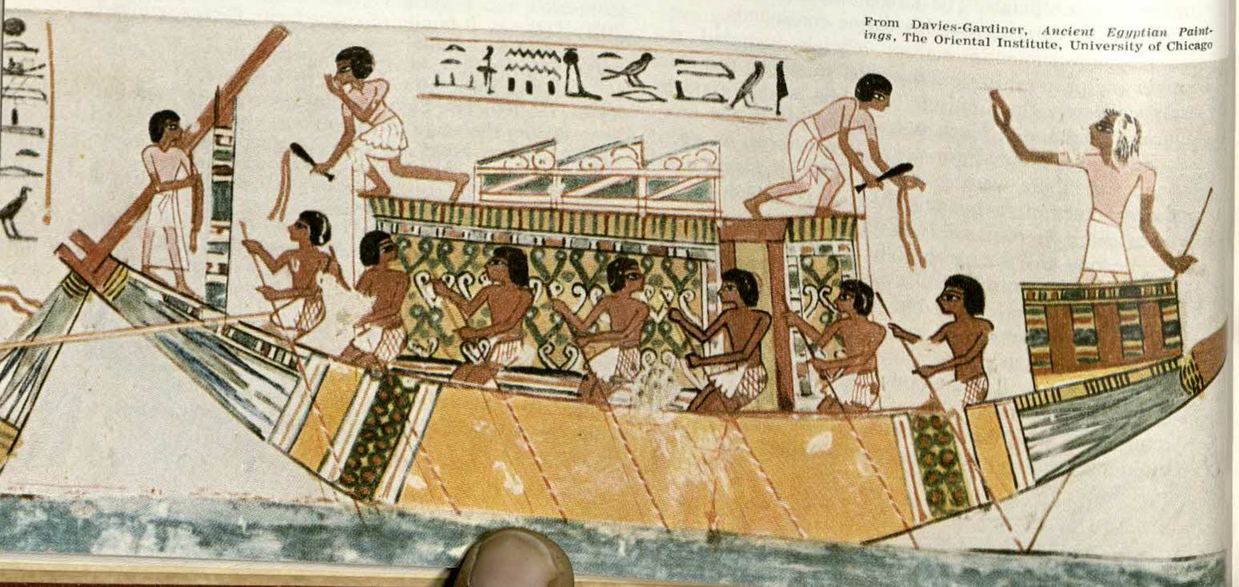


A Hippopotamus provided the model for this clay toy made by an Egyptian artist around 1800 B.C. He decorated it with a design of flowers that grow near the Nile.

The Metropolitan Museum of Art, New York

Boats on the Nile carried important government officials or priests and their families on business and pleasure trips. Slaves, guarded by whip-wielding overseers, rowed the boat. This painting, made about 1400 B.C., is now in the British Museum, London.

From Davies-Gardiner, *Ancient Egyptian Paintings*, The Oriental Institute, University of Chicago



The government improved and expanded the capital at Memphis. It also developed the valuable copper mines in the Sinai Peninsula and the massive stone quarries in Lower Nubia. Large-scale irrigation projects were built along the Nile River. But the Old Kingdom ended in confusion. Ambitious nobles began struggling for power, and provincial rulers demanded independence from the weakening central government.

The First Intermediate Period (2200-2050 B.C.). Egypt suffered political and social chaos for about 150 years. Rival families competed for the throne, trade declined, and provincial rulers fought civil wars. Yet the people benefited in two ways from this confusion. About 2000 B.C., Egypt's rulers decided that justice was more important than property. High priests proclaimed that other persons besides the king could go to heaven. They decreed that Osiris, one of the principal gods, would judge the dead. Persons who could show that they had led good lives might become gods and live forever in the next world.

The Middle Kingdom (2050-1800 B.C.) began with Egypt reunited by nobles from Thebes. They built a nation in which the king did not have absolute powers. Then strong kings of the twelfth dynasty recovered complete authority.

King Amenemhet III, one of the strong rulers, resumed trade with other countries. He established merchant colonies in Phoenicia and at the Third Cataract of the Nile. Under his forceful rule, Egyptian influence expanded south into Nubia and east beyond the Sinai Peninsula into Palestine and Syria.

The Second Intermediate Period (1800-1570 B.C.). Weak rulers allowed local princes to regain some of their independence during the five dynasties that followed the Middle Kingdom. Then Egypt faced another danger. A wandering horde of peoples known as the Hyksos swept into Egypt from Asia about 1730 B.C. They used such new tools of war as the horse and chariot, body armor, and new types of bronze weapons. The Hyksos dominated Egypt for about 160 years.

The Early New Kingdom (1570-1300 B.C.). The Egyptians learned from the Hyksos how to use the new weapons. They drove the invaders back into Asia about 1570 B.C., restored peace, and strengthened the nation's economy. Queen Hatshepsut sent trading expeditions to other parts of Africa, and built many beautiful temples and palaces. For a time, she ruled Egypt jointly with the able King Thutmose III (see Thutmose III).

When Thutmose III became sole ruler, he ended Hatshepsut's peaceful policy and began a series of military campaigns that lasted about 20 years. His armies pushed Egypt's frontiers as far northeast as the upper waters of the Euphrates River in Asia. He conquered Palestine, Syria, and the Nile River as far south as the Fourth Cataract. Under his vigorous leadership, the Egyptian Empire achieved its greatest size (see the *Color Map* at the beginning of this article). The empire he created lasted for 100 years. Thutmose worked out a colonial administration that helped Egypt hold its widespread possessions. He made Thebes and Memphis the political, commercial, and cultural centers of the world. But he also enslaved thousands of people from conquered countries.

The Amarna Revolution shook the Egyptian Empire for a generation. It began about 1370 B.C., when King Amenhotep IV came to the throne. He worshiped the life-giving power of the sun. He called the sun *the Aton*, and changed his own name to *Akhenaton*. Akhenaton considered the worship of the Aton a personal religion for himself and his family.

Akhenaton developed a religion that approached *monotheism*, or belief in one god. He outlawed the worship of more than one god, and forced the people to worship him as a god-king and as the son of Aton. He moved the capital of Egypt from Thebes, because the city was the center of worship of Amon. Akhenaton established the capital at Akhetaton, about 300 miles north of Thebes. The ruins of the city lie near the present village of Tell el-Amarna.

In 1887, archaeologists discovered a huge collection of letters and documents buried in the ruins of Amarna. These clay tablets recorded political conditions in Egypt's Asiatic empire. Historians call this period in Egyptian history *the Amarna Revolution*, because of the many changes in artistic, literary, religious, and social practices from previous dynasties. During Akhenaton's reign, the Egyptians began calling their king *pharaoh* (see Pharaoh).

ANCIENT EGYPT'S DYNASTIES

Historians divide ancient Egyptian history into 30 *dynasties*, or families of rulers. The period before 3100 B.C. is Egypt's *predynastic* era, before families of rulers reigned. Groups of dynasties make up *periods*, as shown in the following table:

Dates	Dynasties	Periods
3100-2700 B.C.	I-II	Early Period
2700-2200 B.C.	III-VI	Old Kingdom
2200-2050 B.C.	VII-XI	First Intermediate Period
2050-1800 B.C.	XII	Middle Kingdom
1800-1570 B.C.	XIII-XVII	Second Intermediate Period
1570-1300 B.C.	XVIII	Early New Kingdom
1300-1090 B.C.	XIX-XX	Later New Kingdom
1090-945 B.C.	XXI	Post-Empire Period
945-745 B.C.	XXII	Libyan Period
745-663 B.C.	XXIII-XXV	Sudanese Period
663-525 B.C.	XXVI	Saite Period
525-332 B.C.	XXVII-XXX	Persian Period

Nefertiti, Akhenaton's queen, had great influence on her husband's attempts at reform. She is one of the best-known Egyptian queens, because she is shown in a limestone bust found by archaeologists (see Egypt [modern], picture).

The Egyptian people did not readily accept all Akhenaton's changes. He concentrated so much on affairs at home that outlying possessions revolted. His successor ruled almost no territory outside Egypt. The Hittites overran parts of the Egyptian Empire in Asia. Priests forced King Tutankhamon, one of Akhenaton's sons-in-law, to return to the old religion of worshiping many gods. Thebes once more became the capital.

The Later New Kingdom (1300-1090 B.C.) includes the nineteenth dynasty, which has been called ancient Egypt's *Golden Age*. During this period, the Egyptians recovered their empire in Asia and their leading position in trade and commerce. They had to fight two strong groups of peoples. The Hittites faced Egypt on land in Asia, and the Philistines and other invaders threatened Egypt from the eastern Mediterranean Sea.

King Seti I recaptured Palestine and Syria (see SETI I). His son, Ramses II, fought the Hittites. Ramses' long reign began strongly, but it developed inner weaknesses (see RAMSES II).

By 1150 B.C., the civilized world had entered the Iron Age. Egypt had no sources of iron, and found it increasingly difficult to import the metal from Asia. Egypt could not compete with armies that had iron weapons. It gradually gave up its outlying possessions, such as Palestine. The country never again wielded the same amount of power in the eastern Mediterranean area that it had enjoyed when copper was essential. The nation suffered from a period of extreme inflation. Robbers broke into the great tombs and stole precious treasures. The twentieth dynasty ended with Egypt divided into small states that cooperated in trade and commerce, but competed for political power.

The Period of Invasions. Many nations dominated ancient Egypt during the final period of its history. Libyan princes became the first outsiders to rule the country at this time. Sheshonk I of Libya seized the Egyptian throne about 945 B.C. After about 200 years of Libyan rule, a Sudanese leader named Piankhi led an invading army from the south that overthrew the Libyans. But, within 50 years, the Assyrians from Asia had ousted the Sudanese.

The Assyrians concentrated on other conquests, and allowed the Egyptians to regain some independence. The years from 663 to 525 B.C. are called the *Saite Period*, because the pharaohs reigned at Sais, on the Nile delta. The Egyptians copied old monuments and ways of doing things in their efforts to revive the nation's former glory.

By 525 B.C., the Persians had driven the Assyrians from Egypt. They ruled the country for nearly 200 years. In 332 B.C., Alexander the Great added Egypt to his empire. When Alexander died, one of his leading generals, Ptolemy, succeeded him in Egypt. Ptolemy I took the title of King of Egypt in 306 B.C., and founded the dynasty known as the *Ptolemies*. The dynasty ended when Cleopatra died in 30 B.C.

The Ptolemies developed Egypt's resources and culture, and encouraged trade with other nations. Alexandria became the capital of Egypt. The city prospered and grew until it ranked second only to the powerful city of Rome as the center of culture and population in the Mediterranean world. The Ptolemies established academies and a great library in the city. Alexandria became the intellectual and religious center of the world.

Egypt's rulers may have succeeded too well in developing the country. The Romans became interested in Egypt as a source of grain. In 30 B.C., their armies conquered the country and made it a Roman province.

Roman and Byzantine Rule. The Roman conquest changed little of Egypt's character. A *prefect* governed the country as a personal possession of the Roman emperor. Roman demands on Egypt for more and more grain caused food shortages and widespread poverty.

Christian missionaries discovered that the Egyptians readily accepted the new religion. They emphasized self-denial and a concern with the next world rather than the present life. Egyptians who followed the teachings of Christ became known as *Copts*. The Coptic Church grew strong from A.D. 300 to 500. But Christianity gradually weakened in Egypt.

Byzantine rule over Egypt began about A.D. 395, when the Roman Empire broke into western and eastern sections (see BYZANTINE EMPIRE). In 640, the Arab conqueror, Amr ibn-al-As, led the invasion of Egypt. Alexandria held out until 642. The country became a part of a great Moslem empire, and gradually developed into a Moslem nation. For the story of Egypt after 642, see EGYPT (History).

JOHN A. WILSON

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BIOGRAPHIES

Akhenaton
Alexander the Great
Cleopatra
Khufu
Ptolemy
Ramses II
Seti I
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Tutankhamon

CONTRIBUTIONS TO CIVILIZATION

Alexandrian Library
Ancient Civilization
Architecture (Egyptian)
Bread (History)
Calendar
Clothing (color picture)
Dancing (Development)
Food Preservation (picture)
Furniture (Egypt)
Geometry (History)
Glass (History)
Harp (picture)
Hieroglyphic
Map (History)
Obelisk
Painting (Ancient; color picture, *The Grape Harvest*)
Papyrus
Pyramids
Sculpture (History)
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GODS AND GODDESSES

Amon
Anubis
Horus
Isis
Osiris
Re
Set
Thoth

UNCLASSIFIED

Abydos
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Animal Worship
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Asp
Copts
Hyksos
Irrigation
Lotus
Memnon
Mummy
Mythology
Nile River
Pharaoh
Rosetta Stone
Scarab
Thebes (Egypt)
Valley of the Kings

Outline

I. The Land and Its Resources
  A. Location and Size
  B. Natural Resources
  C. Climate
II. Life of the People
  A. The People
  B. Language
  C. Family Life
  D. City Life
III. Work of the People
  A. Agriculture
  B. Manufacturing
  C. Mining
  D. Trade and Transportation
  E. Communication
IV. Activities of the People
  A. Education
  B. Religion
  C. The Arts
  D. The Sciences
V. Government
VI. History

Questions

Why has Egypt been called the *gift of the Nile?*

How did hieroglyphic writing differ from hieratic?

What were Egyptian students required to learn in the school for scribes?

Why did the Egyptians build pyramids?

How long did ancient Egypt survive as a center of civilization?

When did ancient Egypt reach the height of its power? What were some of its outlying possessions?

Why did the ancient Egyptians call their country the *Two Lands?*

What are some major contributions of the Egyptians in the arts and sciences?

When did the Egyptians begin to use camels for transportation?

What was the chief occupation in ancient Egypt?

EHRLICH, *AYR lick,* **PAUL** (1854-1915), a German bacteriologist, founded chemotherapy and showed that certain dye injections cure certain tropical diseases (see Chemotherapy). He became best known for his discovery of salvarsan, a remedy for syphilis, which he described in 1910. Salvarsan is also called "606", because it was the 606th compound tested. Ehrlich shared the 1908 Nobel prize for physiology and medicine.

With Robert Koch, Ehrlich contributed to our knowledge of the tuberculosis germ. He founded modern hematology by developing techniques for staining the various types of blood corpuscles. He also worked at increasing immunity to disease, including the development of diphtheria antitoxin. Ehrlich was born at Strehlen, Silesia. Henry J. L. Marriott

EICHMANN, ADOLF (1906-), a lieutenant colonel in the Nazi secret police, was charged with playing a leading part in the killing of about 6,000,000 Jews during World War II. He directed the deportation of the Jews from Germany and the occupied countries to concentration camps. After the war, Eichmann lived in Argentina under an assumed name. Israeli agents seized him there in May, 1960, and took him to Israel for trial on charges of mass murder. Eichmann was born in Solingen, in the Ruhr district of Germany.

EIDER DUCK, *I dur,* is the name of several ducks which live close to sea waters. Eider ducks are famous for the soft, warm down on their breasts. This down is widely used to make the finest pillows and bedding. The *common eider duck* is the most important. It lives in northern waters of Europe, and prefers to rest on rocky islets near shore. The common eider weighs about 4 to 5 pounds. The male duck is black underneath with a creamy-white head and back. The female is a dark reddish-brown, streaked with brown and black. The female usually lays four to six pale greenish-olive eggs. The female plucks soft down from her breast and uses it to cover the eggs. These ducks are carefully protected by authorities during their breeding season in Iceland and Norway.

In America, the common eider is found from Labrador to New England. The *king eider* lives along the coasts of northern North America.

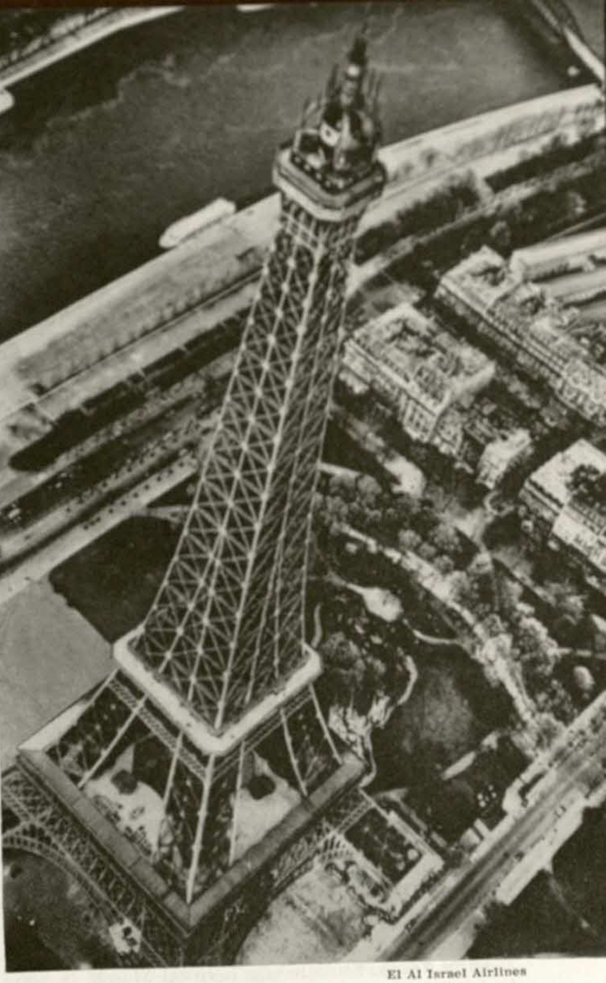
Scientific Classification. Eiders belong to the family *Anatidae.* The common eider is genus *Somateria,* species *mollissima;* the king is *S. spectabilis.* Joseph J. Hickey

EIELSON, CARL BEN. See Alaska (Famous Alaskans).

EIFFEL, *I ful,* **ALEXANDRE GUSTAVE** (1832-1923), was the French structural and aeronautical engineer who designed the 984-foot Eiffel Tower in Paris for the World's Fair of 1889. He introduced the use of compressed air for sinking foundation caissons in bridge construction. His structures include the Garabit Viaduct in southern France; the Douro River bridge at Pôrto, Portugal; a movable observatory dome at Nice, France; and the framework for the Statue of Liberty. Eiffel was born at Dijon, in France. See Portugal (picture, Luis I Bridge). Robert W. Abbett

EIFFEL TOWER, *I ful,* is a huge wrought-iron skeleton tower on the Champ de Mars in Paris. Alexandre Gustave Eiffel designed it for the exposition of 1889.

The tower rises to a height of 984 feet from a base 330 feet square. Elevators and stairways lead to the platforms and to the top. Restaurants, a weather station, and spaces for experiments occupy the platforms.



El Al Israel Airlines

The Eiffel Tower rises 984 feet in the air on the Champ de Mars in Paris. When it was built in 1889, it ranked as the greatest engineering marvel in the world.

The Eiffel Tower contains 7,000 tons of iron and steel and cost over $1,000,000. The fees for the year 1889 alone nearly covered this cost.

For many years the Eiffel Tower was the highest structure in the world. It served as an important military observation station during World War I. Since 1953, the tower has been used to transmit television programs. The Empire State and Chrysler buildings in New York City now are higher. Alan K. Laing

See also Eiffel, Alexandre G.; France (picture).

EIGHT-HOUR DAY. See Wages and Hours.

EIGHTEENTH AMENDMENT. See United States Constitution (Amendment 18); Volstead Act.

EIGHTFOLD PATH. See Buddhists.

EIKON. See Icon.

EILSHEMIUS, *ile SHE mih us,* **LOUIS MICHEL** (1864-1941), was an American landscape painter. He also painted imaginative subjects, tender and naïve in spirit, and lyrical in color. He did his best work late in life, and was not recognized until he was past 60. Eilshemius was born at Laurel Manor, N.J., and studied in Switzerland and Germany. He returned to the U.S. at 17 to attend Cornell University and the Art Students League in New York City. Eilshemius traveled extensively from 1895 to 1910. Edwin L. Fulwider

EINSTEIN, *EYN stine,* **ALBERT** (1879-1955), was one of the greatest scientists of all time. He is best known for his theory of relativity, which he first advanced in 1905, when he was only 26. He also made many other contributions to science.

Relativity. Einstein's relativity theory revolutionized scientific thought with new conceptions of time, space, mass, motion, and gravitation. By treating matter and energy as exchangeable, not distinct, he laid the basis for splitting the atom.

Thus, Einstein was one of the fathers of the atomic age. His famous equation, $E=mc^2$ (energy equals mass times the velocity of light squared), became a foundation stone in the development of atomic energy. Einstein arrived at his theory by means of highly involved mathematical calculations and equations, but he denied that there were "at most only a dozen people in the world who could understand and test his theory." He always insisted that anyone thoroughly at home in the intricacies of higher mathematics could both understand and test his theory. See Relativity.

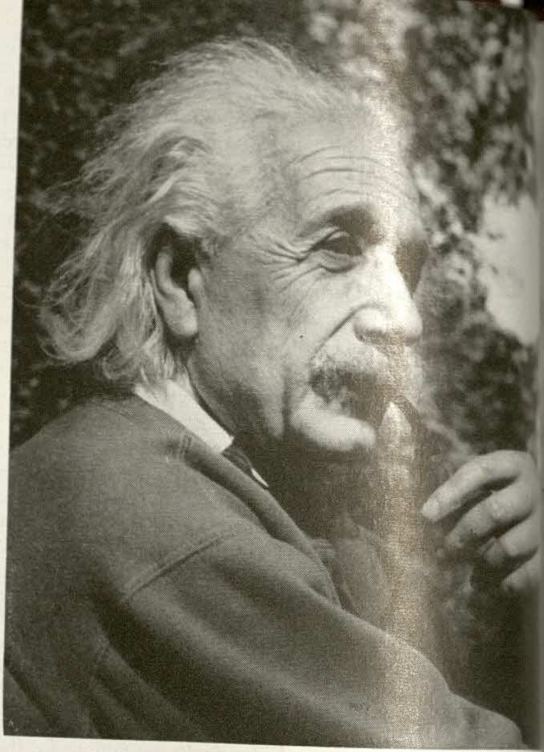
Urged Atomic Research. Einstein's theories were used in producing the atomic bomb. But he played still another part in this development. On Aug. 2, 1939, he wrote a letter to President Franklin D. Roosevelt, warning the President that Germany was working on nuclear fission. As a result, the United States government undertook the long, tedious, and costly work that finally led to the achievement of nuclear fission on Dec. 2, 1942, in a squash court of the University of Chicago's abandoned football stadium. This led to the production of the atomic bomb in 1945. See Atomic Bomb.

Early Years. Einstein was born on March 14, 1879, in Ulm, Württemberg, Germany, the son of Hermann and Paulina Koch Einstein. At five, when his father showed him a pocket compass, the little boy was deeply impressed by the mysterious behavior of the compass needle, which kept pointing in the same direction no matter which way the compass was turned. He later said he felt then that "something deeply hidden had to be behind things."

After public school in Munich and in Aarau, Switzerland, Einstein studied mathematics and physics at the Swiss Polytechnic Institute in Zurich. He was graduated in 1900. From 1902 to 1909, he worked as an examiner at the Swiss Patent Office in Bern. This job as patent examiner allowed him much free time, which he spent in scientific investigations. He became a Swiss citizen in 1905.

The Papers of 1905. During this time, Einstein made three of his greatest contributions to scientific knowledge. The year 1905 was an epoch-making one in the history of physical science, because Einstein contributed three papers to *Annalen der Physik* (Annals of Physics), a German scientific periodical. Each of them became the basis of a new branch of physics.

In one of the papers, he used the quantum theory to explain the photoelectric effect (see Quantum Theory). This effect takes place when light hits certain substances, particularly metals, with sufficient force to release electrons. Einstein showed that when *quanta,* or packets, of light energy strike metal they force it to release electrons. These electrons can form an electric current, as in a photoelectric cell. This helped justify the quantum theory and explained the photoelectric effect in a way that could not be done while scientists assumed that light travels only in waves.



Trude Fleischmann

Albert Einstein became famous for his theory of relativity, which laid the basis for the release of atomic energy.

One result of this work was the photoelectric cell, or "electric eye," which made possible sound motion pictures, television, and many other inventions (see Electric Eye). Einstein received the 1921 Nobel prize in physics for this paper.

A second paper related mass to energy and yielded the famous equation $E=mc^2$, which was used to work out some of the basic problems of atomic energy. The third paper, "The Electrodynamics of Moving Bodies," set forth the special theory of relativity, with which Einstein's name is most universally associated. A manuscript copy of this paper was sold for $6,000,000 at a war bond rally in Kansas City in 1944, and was later deposited with the Library of Congress in Washington, D.C.

A fourth paper of 1905 concerned the *Brownian movement,* an irregular movement of ultramicroscopic particles suspended in a liquid or gas. It confirmed the atomic theory of matter.

Einstein accomplished all this before he held any academic position. But in 1909, he became professor of theoretical physics at the University of Zurich in Switzerland. In 1911 and 1912, he occupied the same position at the German University in Prague. He returned in 1912 to a similar post at the Federal Institute of Technology in Zurich.

Einstein was elected to the Prussian Academy of Sciences in Berlin in 1913. When he accepted the professorship of physics at the University of Berlin in 1914, he once more assumed German citizenship. The same year, he became director of the Kaiser Wilhelm Physical Institute in Berlin. He occupied both positions until 1933.

In 1916, Einstein expanded the special theory of relativity to the general theory, in which he attempted to express all laws of physics by *covariant* equations, or equations that have the same mathematical form regardless of the system of reference to which they are applied.

Unified Field Theory. Einstein first announced his unified field theory in 1929. In it, he aimed at combining gravitational and electromagnetic equations in a single theory (see ELECTROMAGNETISM; GRAVITATION). He published revisions of this theory in 1950 and again in 1953. Late in 1949, he published his "generalized theory of gravitation," which marked a further step toward his goal.

Einstein spent the last 25 years of his life working on the unified field theory. At the time of his death in 1955, he felt that he had not fully succeeded in establishing and proving it. However, Charles W. Misner and John A. Wheeler, in an article published in the *Annals of Physics*, in 1957, claimed that Einstein's latest equations demonstrated the unified field theory. But Einstein himself did not seem to be aware of the fact. Most of the world's foremost physicists had doubted the possibility of a unified field theory. But Einstein never gave up either his hope for it or his work on it.

Einstein in the U.S. In 1933, while Einstein was visiting England and the United States, the Nazi government of Germany took his property and deprived him of his positions and citizenship. Even before this happened, however, he had been invited to direct the school of mathematics in the newly created Institute for Advanced Study in Princeton, N.J.

Einstein accepted this position for life, and settled down in a simple two-story frame house at 112 Mercer St. in Princeton. He lived and worked there until his death. In 1940, Einstein became an American citizen. He died on April 18, 1955.

His Personal Life. Although he lived a quiet personal life, Einstein maintained a vital interest in human affairs. He was fond of classical music, and played the violin. He had a deep compassion for people who were politically or economically oppressed. He was always a champion of the underdog. He supported Zionism, and was offered the presidency of the state of Israel when President Chaim Weizmann died in 1952 (see ZIONISM). But he declined this honor, insisting that he was not fitted for such a position.

Until the outbreak of World War II, Einstein was an ardent pacifist. After the war, he became an equally determined supporter of world government. He insisted that peace among nations could be maintained in the atomic age only by bringing all men together under a system of world law.

Although not well-to-do, Einstein was never concerned about money. Publishers and editors from all parts of the world offered him huge sums for an autobiography. He never bothered to consider such offers. Finally, he did write his "Autobiographical Notes" because, as he put it, "it is a good thing to show those who are striving alongside of us, how one's own striving and searching appears to one in retrospect." Those "Notes" were the only document even approaching an autobiography that Einstein ever wrote. He wrote them for a scholarly volume without asking for or receiving any money.

Einstein was married twice. He was separated from his first wife soon after his arrival in Berlin. During World War I, he married his first cousin, Elsa, who faithfully shared his life until her death at Princeton in 1936. He had two sons by his first marriage. He gained two stepdaughters in the second.

Although he was not associated with any orthodox religion, Einstein's nature was deeply religious. Merely to come into his presence was always a profoundly spiritual experience. Although he felt that belief in a personal God was too specific a concept to be applicable to the Being at work in this universe, he never believed that the universe was one of chance or chaos. The universe to him was one of absolute law and order. He once said, "God may be sophisticated, but he is not malicious." PAUL ARTHUR SCHILPP

EINSTEIN THEORY. See RELATIVITY.

EINSTEINIUM, *ine STINE ih um* (chemical symbol, Es), is one of the man-made radioactive elements. Its atomic number is 99. The most stable isotope of einsteinium has a mass number of 254. Scientists at the University of California, the Argonne National Laboratory, and the Los Alamos Scientific Laboratory named this element in honor of the famous scientist Albert Einstein. Einsteinium was first discovered in 1952 in the debris from a hydrogen bomb explosion. Scientists collected this debris on filter papers carried by radio-controlled airplanes and from fallout on a nearby coral atoll. This new element formed when neutrons from the explosion hit atoms of uranium-238, and were captured by its nucleus. Fermium, element 100, was formed at the same time. Scientists first made einsteinium in a laboratory in 1954, but only minute quantities have been produced. Einsteinium is unstable, and immediately begins turning into lighter elements by radioactive decay. Its different isotopes have a half-life of from 7 minutes to 280 days.

See also ATOM; EINSTEIN, ALBERT; ELEMENT, CHEMICAL; ISOTOPE; RADIOACTIVITY. JAMES S. FRITZ

EINTHOVEN, *EYNT HOH vun*, **WILLEM** (1860-1927), a Dutch physiologist, was the founder of electrocardiography. In 1903, he invented his famous *string galvanometer*, which records variations of electrical current or potential with unequalled sensitivity and speed of response. With it, he was able to record the minute electrical impulse that travels through the heart with every beat. Modern electrocardiography is the direct outcome of papers published by Einthoven in 1907 and 1908 (see ELECTROCARDIOGRAPH). He also used his galvanometer to record the electrical impulses of nerves, heart sounds, and radio waves sent from the Dutch East Indies to The Netherlands. He received the 1924 Nobel prize for physiology and medicine for his investigation of the electrical currents of the heart, and was elected to foreign membership in the British Royal Society in 1926.

Einthoven was born in Semarang, Java. His family moved to The Netherlands in 1870. He studied at the University of Utrecht, and became professor of physiology at the University of Leiden at 25. HENRY J. L. MARRIOTT

ÉIRE. See IRELAND.

F. D. ROOSEVELT
32nd President
1933 — 1945

TRUMAN
33rd President
1945 — 1953

DWIGHT D. EISENHOWER

Dwight D. Eisenhower

34TH PRESIDENT OF THE UNITED STATES 1953-1961

Karsh, Ottawa

EISENHOWER, DWIGHT DAVID (1890-), became President eight years after leading the Allied armies to victory in Europe during World War II. As a general, he commanded the greatest army in history. As President, he dedicated himself to fighting for peace.

When World War II began in 1939, Eisenhower was a little-known lieutenant colonel. Four years later, he became supreme commander of the Allied armies in Europe. He united these armies into a fighting force that smashed Nazi Germany's dream of world conquest. Eisenhower later served as the first military commander of the North Atlantic Treaty Organization (NATO).

In 1953, Eisenhower became the first Republican President in 20 years. He succeeded Harry S. Truman and was followed by John F. Kennedy, both Democrats. Eisenhower suffered three major illnesses during his two terms as President. But he lived to be, at the age of 70, the oldest President in American history.

People in all parts of the world loved the tall, baldheaded man they fondly called "Ike." His broad grin and friendly manner could put almost anyone at ease. Eisenhower showed patience and tact in working with leaders of many nations. He had great skill in persuading people to forget their differences and join together in a common cause. As President, Eisenhower visited world leaders in 29 countries on four continents. He traveled more miles than any earlier President.

Throughout his presidency, Eisenhower faced many difficult decisions. Communist aggression in Asia, Africa, and Latin America caused one crisis after another. Russian achievements in exploring space cast grave doubts on American scientific leadership. At home, fear of communist influence in government led to widespread loyalty investigations. New civil rights laws aroused bitter disputes.

Eisenhower met the challenges of his time with courage and a firm desire to achieve peace. Even his critics never questioned his honesty and sincerity.

Early Life

Boyhood. Dwight David Eisenhower was born in Denison, Tex., on Oct. 14, 1890. He was the third of

KENNEDY
35th President
1961 —

the seven sons of David Jacob Eisenhower and Ida Elizabeth Stover Eisenhower. His parents named him David Dwight, but called him Dwight. By the time he reached high school, he had reversed his names.

Eisenhower's ancestors were German and Swiss immigrants who had sailed to America in the 1730's to seek religious freedom. His parents belonged to the River Brethren, or the Church of the Brethren in Christ. They opposed war or any kind of violence.

When Dwight was nearly 2 years old, the family moved to Abilene, Kans. His father worked as a mechanic in a creamery. The Eisenhowers were among the poorer families in Abilene. Ida Eisenhower grew fruits and vegetables on the three-acre lot that surrounded the house. She sold whatever the family could spare. As each son became old enough, he took a part-time job at the creamery. One of Dwight's brothers died as an infant. The others were Arthur (1886-1958), Edgar (1889-), Roy (1892-1942), Earl (1898-), and Milton (1899-). See EISENHOWER, MILTON STOVER.

In grade school, Edgar was nicknamed "Big Ike" and Dwight became "Little Ike." As adults, "Little Ike" stood about two inches taller than "Big Ike."

While in high school, Dwight worked nights at the creamery. The 1909 class yearbook predicted that he would become a professor of history at Yale University. It also forecast that Edgar would serve two terms as President of the United States.

West Point Cadet. After high school, Eisenhower took a full-time job at the creamery. He planned to help pay Edgar's first-year college expenses, and then to enter college himself. In 1910, a friend persuaded Eisenhower to join him in applying to the U.S. Naval Academy at Annapolis. Eisenhower also applied for an appointment to the U.S. Military Academy at West Point. He received the West Point appointment. Because of their religion, Eisenhower's parents did not approve of his entering military service. But they allowed him to choose his own career.

IMPORTANT DATES IN EISENHOWER'S LIFE

1890 (Oct. 14) Born in Denison, Tex.
1915 Graduated from West Point.
1916 (July 1) Married Mamie Geneva Doud.
1942 Named commanding general of American forces in the European Theater of Operations.
1943 Named supreme commander of the Allied Expeditionary Force in Europe.
1944 (June 6) Led the Allied invasion of Europe.
1950 Named supreme commander of NATO forces in Europe.
1952 Elected President of the United States.
1956 Re-elected President.
1961 Retired to his farm in Gettysburg, Pa.

Eisenhower entered West Point in June, 1911. His classmates included Omar N. Bradley, James Van Fleet, and other men who became famous generals. Eisenhower played halfback on the football team. He twisted a knee in a game against the Carlisle Indians and their all-American star Jim Thorpe. In the next game, Eisenhower broke the knee and had to give up football. He was graduated in 1915, 61st in a class of 164. The army assigned Second Lieutenant Eisenhower to Fort Sam Houston, near San Antonio, Tex.

Eisenhower the Soldier

Eisenhower's Family. During his first year of army duty, Eisenhower met Mamie Geneva Doud (Nov. 14, 1896-), the daughter of a wealthy meat packer. The Douds lived in Denver, but spent winters in the warm San Antonio climate. Eisenhower and Miss Doud were married on July 1, 1916. Eisenhower was promoted to first lieutenant on his wedding day.

The Eisenhowers had two sons. The first, Doud Dwight Eisenhower, died of scarlet fever at the age of 3. The second son, John Sheldon Doud Eisenhower (1922-), was graduated from West Point in 1944. He became a career army officer.

Early Military Career. During and after World War I, Eisenhower trained tank battalions at various army bases. He won the Distinguished Service Medal for his work in 1918 as commander of the tank training center at Camp Colt, in Gettysburg, Pa.

Eisenhower served as executive director of Camp Gaillard in the Panama Canal Zone from 1922 to 1924. His commander, Brigadier General Fox Connor, was convinced that another world war would soon be fought. He urged Eisenhower to prepare himself to play an important part in that war. With Connor's help, Eisenhower was chosen to attend the Command and General Staff School at Fort Leavenworth, Kans. The course was so hard that many officers broke down under the strain. In 1926, Eisenhower was graduated first in a class of 275. Two years later, he was graduated from the Army War College in Washington, D.C.

Eisenhower held various posts during the next few years. In 1933, he became an aide of General Douglas MacArthur, who was then Chief of Staff of the United States Army. MacArthur was named military adviser to the Commonwealth of the Philippines in 1935, and Eisenhower went with him as his assistant. Eisenhower helped establish the Philippine Air Force and the Philippine Military Academy. He learned to fly a plane, and obtained a pilot's license at the age of 47. He was the first President to have a pilot's license.

World War II Begins. Eisenhower was an executive officer at Fort Ord, near San Francisco, when World War II began in 1939. His fellow officers called him "Alarmist Ike," because he was so sure that the United States would soon be in the war.

In March, 1941, Eisenhower became a full colonel. Three months later, he was made chief of staff of the Third Army with headquarters at San Antonio, Tex. His brilliant record in maneuvers earned him a promotion to brigadier general in September, 1941. It also brought him to the attention of General George C. Marshall, army chief of staff.

John Crawford

Eisenhower's Birthplace was this white frame house in Denison, Tex. The family moved to Abilene, Kans. when Dwight was nearly 2 years old.

◀

▶

Mamie Eisenhower set a fashion by wearing her hair in bangs. The pink color of her inaugural ball gown of 1953 became known as "Mamie pink."

Wide World

On Dec. 12, 1941, five days after the Japanese attacked Pearl Harbor, Marshall appointed Eisenhower to the army's War Plans Division. Eisenhower worked on plans to defend U.S. possessions in the Pacific. He also began charting an Allied invasion of Europe. In March, 1942, Eisenhower became head of the Operations Division of the War Department, and was promoted to major general. He drew up plans to unify all American forces in Europe under one commander. In June, three days after submitting his plan, Eisenhower was named commanding general of American forces in the European Theater of Operations. He had been advanced over 366 senior officers eligible for the job.

Victory in Africa, Sicily, and Italy. Eisenhower set up headquarters in London in June, 1942. He began planning to bring 2,000,000 American soldiers to Britain. In July, he was promoted to lieutenant general.

During the summer, Eisenhower met with British and American leaders to plan *Operation Torch*, the first major Allied offensive. Their goal was to invade French North Africa and drive out the German and Italian armies. Eisenhower was named commander of the Allied invasion forces. The Allies landed on the coast of Algeria and Morocco on Nov. 7, 1942. By May, 1943, they had conquered North Africa.

Eisenhower became a full general in February, 1943. He now turned his attention to an Allied invasion of Sicily and Italy. Time after time, he emphasized the importance of British and American unity. "This is an Allied battle," he told his men. ". . . There will be neither praise nor blame for the British as British or the Americans as Americans."

The Allies occupied all Sicily on Aug. 17, 1943. They invaded Italy in September, 1943. Rome fell on June 4, 1944, after a long, hard battle. For accounts of these campaigns, see WORLD WAR II (The North African Campaign; The War in the Mediterranean).

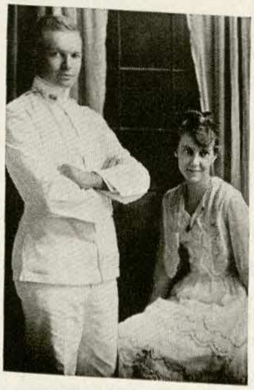
Supreme Commander. During the Italian campaign, Eisenhower met with President Franklin D. Roosevelt and Prime Minister Winston Churchill of Great Britain to plan an invasion of Europe. They agreed to cross the English Channel and invade Normandy, in northern France. The plan was called *Operation Overlord.*

At first, Roosevelt intended to appoint Marshall to command the European invasion. He planned to have Eisenhower replace Marshall as chief of staff. But the President later thought it might be "dangerous to monkey with a winning team." In early December, 1943, he told Eisenhower: "Well, Ike, you are going to command Overlord." By January, 1944, Eisenhower was in London directing Supreme Headquarters Allied Expeditionary Force (SHAEF). Eisenhower gave endless attention to the troops' morale, which he considered "the greatest single factor in successful war."

The Great Decision. Eisenhower chose Monday, June 5, 1944, as D-Day, the date for invading Europe. The success of the invasion depended heavily on calm seas and clear skies. On Saturday, June 3, the weather turned bad. Weather experts reported that gusty winds and high waves would make it impossible for landing craft to cross the English Channel on Monday. Eisenhower ordered a 24-hour delay until Tuesday, June 6. On Sunday, the weathermen predicted calmer weather for the next 48 hours, but poor conditions after that.

Eisenhower faced one of the gravest decisions of the entire war. He could send the first wave of troops across the channel as planned. But bad weather might halt further landings. Or he could postpone the entire operation for two weeks, until the channel would have low tides again. But, by then, the closely guarded invasion secret would probably have leaked out.

At 4 A.M. on June 5, Eisenhower held a final staff meeting. His chief of staff, Brigadier General Walter



On His Wedding Day, First Lieutenant Eisenhower refused to sit down before the ceremony. He feared creasing the crisp trousers of his uniform.

United Press Int.

General "Ike" often met with Prime Minister Winston Churchill to map World War II plans. Eisenhower commanded the Allied armies in Europe.

Bedell Smith, later wrote: "... He sat there ... tense, weighing every consideration ... Finally, he looked up, and the tension was gone from his face. He said briskly, 'Well, we'll go.' "

The first wave of troops crossed the choppy channel at 6:30 A.M. on June 6, 1944. By nightfall, the Allies had a firm hold on a long area of beach. After 11 months of bloody fighting, Germany surrendered on May 7, 1945. For the story of the victory in Europe, see WORLD WAR II (The Invasion of Europe).

Road to the Presidency

Chief of Staff. Eisenhower was now 54 years old. In December, 1944, he had been promoted to General of the Army. He wrote a friend: "For myself, there is nothing I want so much as opportunity to retire." But the nation still needed his services. In November, 1945, he replaced General Marshall as army chief of staff.

Eisenhower's major task was *demobilization*, or disbanding the armed forces. He argued for a slow rate of military discharge. He also wanted a system of universal military service to insure the nation against surprise attack (see DRAFT, MILITARY [Selective Service]). But he had to give in to many demands of a nation anxious to have its men back at peacetime jobs.

Eisenhower also worked to unify all the armed services under one command. He met strong opposition from members of the various services who distrusted such a centralized system. In 1947, Congress passed a compromise measure unifying the armed forces under a single Secretary of Defense (see DEFENSE, DEPARTMENT OF).

University President. In 1948, Eisenhower retired from active duty and became president of Columbia University. He wrote a book about his World War II experiences, called *Crusade in Europe*, which he sold for $635,000. The book was a best seller. National demands kept Eisenhower from devoting himself entirely to university work. He frequently testified before congressional committees on defense policies. He also advised the government on merging the War and Navy departments into the new Department of Defense.

NATO Commander. In December, 1950, the North Atlantic Treaty Organization made Eisenhower supreme commander in Europe (see NORTH ATLANTIC TREATY ORGANIZATION). He took up his duties at Supreme Headquarters Allied Powers Europe (SHAPE) near Paris in April, 1951. Once again, Eisenhower joined many armies into one force. He remarked that this was the first time a great allied army had been created "to preserve the peace and not to wage war."

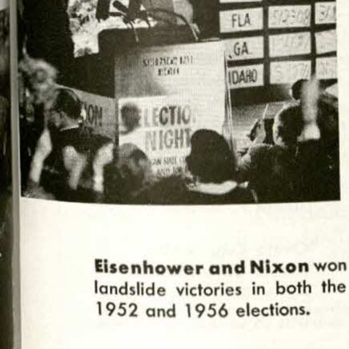
Election of 1952. As early as 1943, some Americans had wanted Eisenhower to run for President. He had replied angrily: "Why can't a simple soldier be left alone to carry out his orders?"

In 1948, Eisenhower turned down attempts by both the Republican and Democratic parties to "draft" him for the presidential nomination. He insisted that "lifelong professional soldiers" should not enter politics. When a friend asked Eisenhower what party he favored, he replied: "I am just a good Kansas Republican like yourself." By 1952, Republican demands had grown too strong to resist. Eisenhower came home in June to campaign for the nomination. The next month, he retired from the army without pay or military benefits.

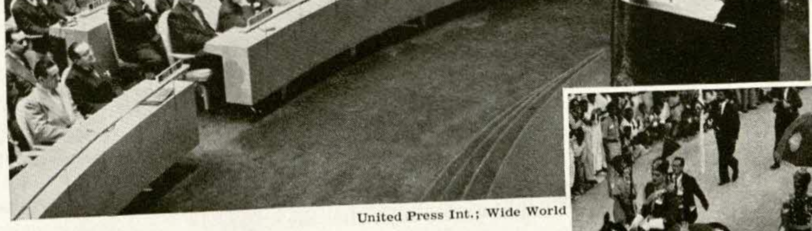
The 1952 Republican national convention nominated Eisenhower on the first ballot, and chose Senator Richard M. Nixon of California for Vice-President. The Democrats nominated Governor Adlai E. Stevenson of Illinois for President and Senator John J. Sparkman of Alabama for Vice-President.

EISENHOWER'S FIRST ELECTION

Place of Nominating Convention	Chicago
Ballot on Which Nominated	1st
Democratic Opponent	Adlai E. Stevenson
Electoral Vote	442 (Eisenhower) to 89 (Stevenson)
Popular Vote	33,778,963 (Eisenhower) to 27,314,992 (Stevenson)
Age at Inauguration	62



Eisenhower and Nixon won landslide victories in both the 1952 and 1956 elections.



United Press Int.; Wide World

"Atoms for Peace" plan, one of Eisenhower's major achievements, was presented to the United Nations, *above*, in 1953.

Good-Will Trips earned many friends for the United States. Eisenhower visited Pakistan, *right*, in 1959.

Eisenhower called his election campaign a crusade to "clean up the mess in Washington." He criticized the Democratic administration of President Harry S. Truman for its conduct of the Korean War. In a dramatic speech shortly before the election, Eisenhower pledged: "I shall go to Korea" to help end the war.

In the election, Eisenhower defeated Stevenson easily. He received over 33,000,000 popular votes, more than any previous presidential candidate. The Republicans won control of Congress by small majorities. Shortly after the election, Eisenhower flew to Korea to observe the war at first hand.

Eisenhower's First Administration (1953-1957)

President Eisenhower set up a staff system based on that of the army. He made each Cabinet officer or other executive responsible for an area of government affairs. Sherman Adams, Assistant to the President, was "chief of staff." He coordinated the work of all these officials, freeing the President of many routine jobs.

Several weeks after Eisenhower took office, the Department of Health, Education, and Welfare was created (see HEALTH, EDUCATION, AND WELFARE, DEPARTMENT OF). Mrs. Oveta Culp Hobby became the first secretary of the department. Her appointment raised the number of Cabinet members to 10.

"Modern Republicanism" was Eisenhower's term for his legislative program. In domestic affairs, he favored strengthening the government's welfare programs. But he also wanted to give more authority to the states and to avoid new measures that might increase federal power. In foreign affairs, he emphasized close cooperation with the nation's allies.

Led by Eisenhower, Congress gave the nation's tax system a thorough overhaul. The social security system was broadened, and the minimum wage was increased to $1 an hour. Congress also authorized a 13-year highway-building program. Eisenhower gave the national defense program a "new look." Instead of large forces, he made atomic weapons the mainstay of U.S. defense. The President defeated a proposed amendment to the Constitution that would have limited his treaty-making powers. He also won a fight to reduce rigid federal supports of farm prices. Another achievement was an agreement between the United States and Canada to cooperate in building the Saint Lawrence Seaway (see SAINT LAWRENCE SEAWAY).

Internal Security. Five months after Eisenhower became President, Ethel and Julius Rosenberg were executed as Russian spies (see ROSENBERG, ETHEL G. and JULIUS). Urged by Eisenhower, Congress passed a series of internal security laws in 1954. These laws outlawed the Communist party. They also provided the death penalty for spying in peacetime, as well as in wartime. Congress also began a widespread investigation of communist infiltration in the government. As a result, hundreds of government workers were fired.

Senator Joseph R. McCarthy of Wisconsin was chairman of the Senate subcommittee that headed the search for communists in government. McCarthy began attacking the Eisenhower administration soon after the President took office. First, he accused Charles E. Bohlen of being a security risk. Eisenhower had nominated Bohlen to be U.S. ambassador to Russia. A special Senate committee cleared Bohlen. Later, Mc-

THE WORLD O

WORLD EVENTS

1953 (March 5) Premier Joseph Stalin of Russia died.
1953 (July 27) The Korean War ended.
1955 Eisenhower held a "summit" conference at Geneva with leaders of France, Great Britain, and Russia.
1957 Russia launched the first man-made satellite.
1959 Fidel Castro became premier of Cuba.

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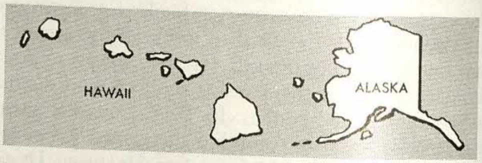
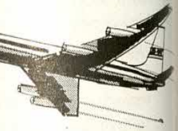
UNITED STATES EVENTS

The United States flag had 48 stars when Eisenhower became President.

U.S. population was 181,700,000 when Eisenhower left office in 1961. Alaska and Hawaii became the 49th and 50th states of the Union in 1959.



1953 Eisenhower proposed his "Atoms for Peace" plan.
1954 The Supreme Court ruled that racial segregation in public schools is unconstitutional.
1955 The American Federation of Labor (AFL) merged with the Congress of Industrial Organizations (CIO).
1958 The first American space satellite was launched.
1958-1959 U.S. airlines began jet passenger service.
1961 The United States ended diplomatic relations with Cuba.



EISENHOWER'S CABINET

Secretary of State	*John Foster Dulles *Christian A. Herter (1959)
Secretary of the Treasury	*George M. Humphrey Robert B. Anderson (1957)
Secretary of Defense	*Charles E. Wilson Neil H. McElroy (1957) Thomas S. Gates, Jr. (1959)
Attorney General	*Herbert Brownell, Jr. William P. Rogers (1957)
Postmaster General	Arthur E. Summerfield
Secretary of the Interior	Douglas McKay Frederick A. Seaton (1956)
Secretary of Agriculture	†Ezra Taft Benson
Secretary of Commerce	Sinclair Weeks Frederick H. Mueller (1959)
Secretary of Labor	Martin P. Durkin James P. Mitchell (1953)
Secretary of Health, Education, and Welfare	*Oveta Culp Hobby *Marion B. Folsom (1955) Arthur S. Fleming (1958)

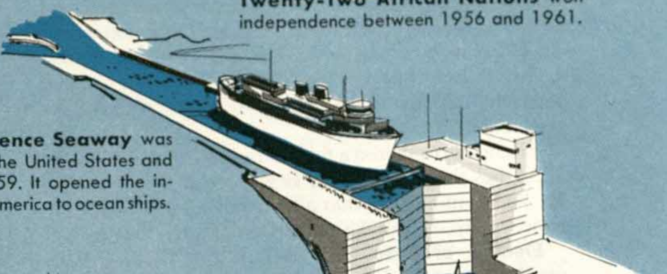
*Has a separate biography in WORLD BOOK.
†See the article UTAH (Famous Utahans).

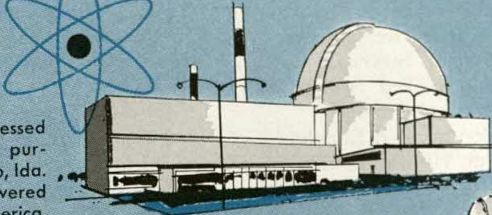
PRESIDENT EISENHOWER

Korean Truce, signed on July 27, 1953, ended three years of bloody fighting.

The Space Age began in 1957 with Russia's Sputniks I and II. America launched its first satellite, Explorer I, in 1958.

Twenty-Two African Nations won independence between 1956 and 1961.


The St. Lawrence Seaway was completed by the United States and Canada in 1959. It opened the interior of North America to ocean ships.


Atomic Power Plants harnessed atomic energy for peaceful purposes. In 1955, a plant at Arco, Ida. produced the first atomic-powered electricity for public use in America.

Department of Health, Education, and Welfare was created in 1953. It administers the government's social welfare programs.

Polio Vaccine, developed by Jonas E. Salk, was declared safe in 1955. Millions received anti-polio shots.

Carthy charged that the United States Information Agency had communist books in its libraries in Europe. In a speech at Dartmouth College, Eisenhower warned: "Don't join the book burners . . . Don't be afraid to go in your library and read every book . . ." But he refused to make a public statement against McCarthy, or to deal "in terms of personality." The Senate censured McCarthy in 1954 (see McCARTHY, JOSEPH R.).

Moves for Peace. President Eisenhower worked to strengthen America's ties with the free nations against the spread of communism. He took every opportunity to show Russia that the United States wanted to end the Cold War (see COLD WAR).

Truce in Korea. Eisenhower's post-election trip to Korea did not bring immediate results. But Secretary of State John Foster Dulles warned Communist China that if it delayed peace talks, the United States would bomb the Chinese supply lines. A truce was signed on July 27, 1953 (see KOREAN WAR).

"*Atoms for Peace.*" In December, 1953, the President proposed that the nations of the world pool atomic information and materials for peaceful purposes. As an outgrowth of this proposal, 62 countries formed the International Atomic Energy Agency in 1957 (see INTERNATIONAL ATOMIC ENERGY AGENCY).

SEATO. Eisenhower and Dulles took the lead in organizing eight nations to resist communist aggression in Southeast Asia. These nations formed the Southeast Asia Treaty Organization (SEATO) in September, 1954 (see SOUTHEAST ASIA TREATY ORGANIZATION).

Summit Conference. In July, 1955, the leaders of France, Great Britain, Russia, and the United States met in Geneva, Switzerland. Eisenhower proposed that America and Russia allow air inspection of each other's military bases. The Russians rejected this "open skies" plan along with other Western proposals.

Illnesses. On Sept. 24, 1955, President Eisenhower suffered a heart attack while vacationing in Denver.

He was taken to a hospital, and a staff of eight leading physicians was summoned. The doctors reported that the attack was "moderate." In October, Eisenhower began directing government policy from his hospital suite. He returned to his desk in December.

The heart attack raised the question of Eisenhower's running for a second term. After weeks of indecision, he announced in February, 1956, that he would seek re-election. "My answer would not be in the affirmative unless I thought I could last out the five years," he said. On June 9, Eisenhower had a sudden attack of ileitis, a disorder of the small intestine, and underwent an emergency operation. This illness cast new doubts on his ability to serve a second term. But the President recovered rapidly, and stood by his decision to run for re-election.

Eisenhower suffered a third serious illness on Nov. 25, 1957, less than a year after beginning his second term. He had a mild stroke that affected his speech for a short time. Again, he quickly regained complete health.

Election of 1956. The Republican national convention renominated Eisenhower by acclamation in 1956. Vice-President Nixon was also renominated. The Democrats again chose Adlai E. Stevenson as their candidate for President, and picked Senator Estes Kefauver of Tennessee as his running mate.

In the campaign, Stevenson accused Eisenhower of being a "part-time" President. He warned that Eisenhower might not survive a second term. The President ignored the issue of his health. He emphasized the "peace and prosperity" of the past four years. Everywhere, crowds greeted him with chants of "We like Ike."

Eisenhower and Nixon won an even greater landslide victory than in 1952. They were the first Republican President and Vice-President to be re-elected as a team. But the voters seemed to like "Ike" more than his party. The Democrats, who had won majorities in Congress in 1954, kept control of both the Senate and House of Representatives. Eisenhower became the first President in more than a hundred years to take office without a majority of his party in either house of Congress. Zachary Taylor had done so in 1849.

Eisenhower's Second Administration (1957-1961)

Life in the White House. The Eisenhowers' eight years in the White House was the longest time they had lived in one place since their marriage. In 1950, they bought a farm in Gettysburg, Pa. It was the first permanent home they had ever owned.

Golf was the President's favorite recreation. On warm days, passers-by could see him practicing golf shots on a special green that was installed on the White House lawn. Eisenhower also liked to cook. Sometimes he invited friends to a "cookout" on the White House roof, where he broiled steaks on a charcoal grill. The President gave many informal "stag" parties for groups of businessmen and national leaders.

EISENHOWER'S SECOND ELECTION

Place of Nominating Convention	San Francisco
Ballot on Which Nominated	1st
Democratic Opponent	Adlai E. Stevenson
Electoral Vote	457 (Eisenhower) to 73 (Stevenson)
Popular Vote	35,581,003 (Eisenhower) to 25,738,765 (Stevenson)
Age at Inauguration	66

HIGHLIGHTS OF EISENHOWER'S ADMINISTRATION

1953 (July 27) The Korean War ended.
1954 (Jan. 21) The United States launched the first atomic submarine, the *Nautilus.*
1954 (May 17) The Supreme Court outlawed racial segregation in public schools.
1957 (Sept. 24) Eisenhower sent U.S. troops to Little Rock, Ark., to enforce school integration.
1957 (Oct. 4) Russia launched Sputnik I, the first man-made satellite.
1958 (Jan. 31) The United States launched Explorer I.
1959 Alaska and Hawaii became states.
1959 (June) The Saint Lawrence Seaway was opened.
1961 (Jan. 3) The United States broke off diplomatic relations with Cuba.

In 1953, Eisenhower restored the custom of Easter egg rolling on the White House lawn (see EASTER EGG ROLLING). On Jan. 19, 1955, he held the first presidential news conference ever televised.

Problems at Home centered around race relations, space travel, Eisenhower's staff, and economic conditions that led to a business recession.

School Integration. In September, 1957, Eisenhower sent federal troops to Little Rock, Ark., to enforce school integration. Governor Orval E. Faubus had defied a 1954 Supreme Court order to end segregation of Negroes and whites in public schools. Faubus ordered the Arkansas National Guard to bar Negro students from Central High School. He warned that rioting would break out if Negroes were admitted to the school. Eisenhower tried to persuade Faubus to enforce the law and prevent rioting. The President finally sent troops to protect the Negro students.

The Space Age began on Oct. 4, 1957, when Russia launched Sputnik I, the first man-made satellite. The Russians launched Sputnik II on Nov. 3. Many Americans worried about the nation's failure to beat Russia in the space race. Eisenhower set up the office of Special Assistant to the President for Science and Technology to advise him. The United States sent its first satellite, Explorer I, into orbit on Jan. 31, 1958. In July, Congress established the National Aeronautics and Space Administration to coordinate American efforts to explore space.

Resignation of Sherman Adams. In 1958, congressional investigators revealed that Sherman Adams had received gifts from a Boston businessman while serving as Assistant to the President. The activities of this businessman were being investigated by the government. Adams admitted accepting the gifts, but denied trying to influence officials in his friend's favor. Eisenhower gave in to demands from both Republicans and Democrats that Adams resign.

A Business Recession occurred in 1957 and 1958. Eisenhower opposed a broad government spending program. He believed such a program would lead to inflation. Business picked up by the summer of 1958.

Congressional Elections in 1958 led to overwhelming Democratic victories. Eisenhower became the first President to serve with three Congresses controlled by the opposing party. He had difficulty winning support for much of his program.

Foreign Affairs caused grave concern. Russia's tactics in the Cold War destroyed Eisenhower's hopes of relieving international tension.

"*Eisenhower Doctrine.*" A series of crises in the Middle East led the President to propose the "Eisenhower Doctrine" in 1957. This doctrine pledged U.S. military aid to any Middle East nation that asked for help against communist aggression. In July, 1958, Eisenhower used the doctrine to send troops to Lebanon to protect the government from rebel forces.

Aid to China. In August, 1958, the Chinese communists began shelling the Quemoy Islands, which were held by the Chinese nationalists. The President ordered the U.S. Seventh Fleet to help convoy nationalist supplies from Formosa to the islands. The communist attacks died down in October.

Relations with Russia. The President entertained Soviet Premier Nikita S. Khrushchev during his visit to the United States in September, 1959. The two leaders paved the way for a second summit conference and a return visit by Eisenhower. In April, 1960, the Russians shot down an American U-2 reconnaissance plane over Soviet territory. Eisenhower admitted that U-2 flights had been going on for four years. Khrushchev used the incident to break up the Paris summit conference in May. He angrily withdrew his invitation for the President to visit Russia.

Break with Cuba. Fidel Castro, who became premier of Cuba in 1959, adopted a violently anti-American policy. In 1960, he seized all property owned by American companies in Cuba. He later charged that the U.S. embassy in Havana was the center of "counter-revolutionary activities" against Cuba. On Jan. 3, 1961, Eisenhower broke off diplomatic relations with Cuba.

Retirement. Eisenhower was the first President whose term of office was limited by the Constitution. Amendment 22 to the Constitution became law in 1951. It restricts a President to two full elected terms.

In March, 1960, four months before the Republican national convention, Eisenhower announced his support of Vice-President Nixon to succeed him as President. Nixon lost the election to John F. Kennedy. Eisenhower left office in January, 1961, and retired to his Gettysburg farm. Two months later, Congress restored his rank as General of the Army. But, as a retired President, he was not entitled to receive a general's salary.

Books about Eisenhower include *Soldier of Democracy* by Kenneth S. Davis and *Eisenhower: The Inside Story* by Robert J. Donovan.

ALLAN NEVINS

Related Articles in WORLD BOOK include:

Adams, Sherman
Dulles, John Foster
Korean War
Nixon, Richard Milhous
North Atlantic Treaty Organization
President of the United States
Republican Party
Stevenson, Adlai Ewing
United States, History of ("Time for a Change")
World War II

Outline

- **I. Early Life**
  - A. Boyhood
  - B. West Point Cadet
- **II. Eisenhower the Soldier**
  - A. Eisenhower's Family
  - B. Early Military Career
  - C. World War II Begins
  - D. Victory in Africa, Sicily, and Italy
  - E. Supreme Commander
  - F. The Great Decision
- **III. Road to the Presidency**
  - A. Chief of Staff
  - B. University President
  - C. NATO Commander
  - D. Election of 1952
- **IV. Eisenhower's First Administration (1953-1957)**
  - A. "Modern Republicanism"
  - B. Internal Security
  - C. Moves for Peace
  - D. Illnesses
  - E. Election of 1956
- **V. Eisenhower's Second Administration (1957-1961)**
  - A. Life in the White House
  - B. Problems at Home
  - C. Foreign Affairs
  - D. Retirement

Questions

How did Eisenhower happen to choose an army career?
How did his personality help him as President?
What new Cabinet post did Eisenhower create?
How did his D-Day decision depend on the weather?
Why did he at first refuse to run for President?
What two proposals for peace did Eisenhower make during his first term?
Why did Eisenhower's health become an issue in his campaign for re-election?
What was the "Eisenhower Doctrine"?
Why did Eisenhower break off relations with Cuba?
Could Eisenhower have run for a third term? Why?

EISENHOWER, MILTON STOVER (1899-   ), a brother of President Dwight D. Eisenhower, is an American educator and administrator who specialized in agriculture, public information, and governmental organization. He became an associate director of the Office of War Information (OWI) in 1942. He went to Africa for OWI to analyze psychological warfare. He became president of Kansas State College in 1943, and of Pennsylvania State College in 1950. Eisenhower also acted as special ambassador to South America for his brother in 1953. He became president of Johns Hopkins University in 1956. Eisenhower was born in Abilene, Kans.

JOHN S. BRUBACHER

EISENSTEIN, *EYE zun STINE*, **SERGEI MIKHAILOVICH** (1898-1948), a Russian motion-picture director, became noted for his new methods in camera angle, cutting, and *montage*, placing a number of images side by side. In his early films, he used untrained actors and made the common people his hero.

Eisenstein was born in Moscow, and was trained as a civil engineer and architect. After the Russian Revolution of 1917, he became art director of the first Workers Theater. In 1924, he turned to motion pictures with *Potemkin* (1926), which won immediate acclaim. His films include *Alexander Nevsky* (1939) and the uncompleted *Ivan the Terrible* (1945).

BARNARD HEWITT

EJECTMENT is an action at common law to regain the possession of land or buildings, and also to obtain damages for the unlawful holding of the property.

EL ALAMEIN, *el AL uh MAIN*, is an Egyptian city at the end of a coastal railroad that connects it with Alexandria, 70 miles to the east. It lies 40 feet above sea level. El Alamein attracted much attention during World War II, when Axis forces advanced from Tobruk as far as the city in their drive toward Alexandria. British troops stood firm at El Alamein in July, 1942. As a result, they stopped the German conquest of Egypt. For location, see EGYPT (color map). See also WORLD WAR II (The North African Campaign).

GEORGE H. T. KIMBLE

ELAMITE. See IRAN (Early Days).

Zoological Society of Philadelphia

The African Eland May Weigh Over 1,000 Pounds.

ELAND, *EE lund,* is the largest antelope found in Africa. There are two principal kinds: (1) the common eland and (2) the Derby eland. The *common eland* lives in an area extending from Kenya to South Africa. The *Derby eland* lives in a region extending from Sudan to western Africa.

The eland of Africa grows as tall as 6 feet at the shoulders, or withers. It has different colors in different regions, from deep chestnut or bluish-gray to pale buff. Most elands have 8 to 15 vertical white lines on the sides of the body and a black stripe down the back. Black patches cover the backs of the forelegs above the knees.

The southern form of the common eland has no markings. Both the female and male eland have spiraled horns. The horns sometimes grow 3 to 3½ feet long.

A mounted hunter can easily run down the slow, heavy eland. It will not charge, and it can be tamed easily.

Scientific Classification. Elands belong to the family *Bovidae.* The common eland is genus *Taurotragus,* species *oryx.* The Derby eland is *T. derbianus.* Victor H. Cahalane

ELASTICITY, *ee* LAS *TIS uh tih,* is the ability of a material to return to its original size and form after it has been stretched or compressed. All substances are elastic to some degree. Gases and liquids have elasticity of *volume.* Their form is merely that of any container that holds them. If gases or liquids are released after being compressed, they tend to return to the same amount of space they occupied before they were compressed. Solids have elasticity of *form,* and tend to spring back to their old shape.

Solids that have little ability to do this are called *inelastic,* or *plastic.* If a body is stretched or compressed far enough it will reach its *elastic limit.* Any more stress will change its form or size.

The force with which a body tends to resume its former shape is called *elastic force.* The repeated application of elastic forces may cause a material to fail. This is known as *fatigue.* Gases are the most perfect of elastic materials because of the accuracy with which the elastic changes may take place. Hard solids are the most elastic of solids because of the large elastic forces developed within them. Springs in watches and automobiles, rubber heels on shoes, and elastic cartilage between the vertebrae of the spinal column are familiar examples of elasticity. Louis Marick

See also Flexibility; Spring (metal).

ELASTOMER. See Rubber (Synthetic Rubber).

ELBA, *EL buh,* is a small, mountainous island in the Mediterranean Sea, six miles southwest of the coast of Tuscany. The island is famous as the place to which Napoleon was exiled in 1814 (see Napoleon I [Exile to Elba]). It has an area of 86 square miles and a population of about 28,000. The chief city is Portoferraio. Products include iron, marble, wine, and fruits. Italy governs Elba as part of Livorno province. For location, see Italy (color map). Benjamin Webb Wheeler

ELBE RIVER, *EHL buh,* is one of the most important commercial waterways of central Europe. The Elbe rises in western Czechoslovakia, flows northwest more than 700 miles, and empties into the North Sea. It has been dredged so that large barges can travel most of its length. The largest ocean-going ships can travel as far as 55 miles inland to the port of Hamburg. For location, see Germany (color map).

The Elbe River basin contains some of Germany's most important farm lands and industrial regions. The important ports include Dresden, Hamburg, Magdeburg, Torgau, and Mělník (in Czechoslovakia). A network of canals connects the Elbe with inland industrial towns, providing transportation for exports to the sea. During Roman days, the Elbe marked the limit of the Roman advance into Germany. It later did the same for the conquests of Charlemagne. Frank O. Ahnert

ELBERT, MOUNT. See Colorado (Land Regions).

EL BOQUERÓN, also known as Barcena Volcano, lies on San Benedicto Island, 350 miles west of Mexico in the Pacific Ocean. The volcano was born on Aug. 1, 1952, when an explosive eruption started at the south end of the island. By mid-August, the volcano had built a cone of volcanic ash about 1,000 feet high. On December 8, a crack opened in the east side of El Boquerón's cone. Lava poured from the crack into the sea, building a deltalike peninsula. The eruption ended in February, 1953. Pumice from the eruption was found as far away as the Marshall Islands in the central Pacific. Gordon A. Macdonald

ELBOW. See Arm.

ELBRUS, MOUNT. See Mount Elbrus.

ELBURZ MOUNTAINS, *ehl BOORZ,* in northern Iran extend for 650 miles from the southwestern shore of the Caspian Sea to the city of Mashad in eastern Khurasan. The western peaks run almost parallel to the seashore, and are only 12 miles from the sea in some places. Magnificent hardwood trees cover the northern Elburz slopes. The highest peak is Demavend (18,934 feet). The city of Tehran rests at the southern foot of the mountains, 4,000 feet above sea level. A desert stretches south and east of the mountains from Tehran. For location, see Iran (color map). Christina Phelps Harris

EL CAMINO REAL, *kah ME no ray AHL,* was an early California highway. It is Spanish for *The Royal Highway.* It ran north from San Diego for 530 miles to Sonoma to connect the Franciscan missions. There were 21 missions along the road in California by 1823, about a day's journey apart. Father Junípero Serra founded the first mission at San Diego in 1769. The mission at San Francisco, now called *Mission Dolores,* was built in 1776. U.S. Highway 101 closely follows the old mission trail. *El Camino Real* was also the name of the oldest road in the United States. It runs through New Mexico. See also CALIFORNIA (color map, Historic California); NEW MEXICO (Transportation). GEORGE SHAFTEL

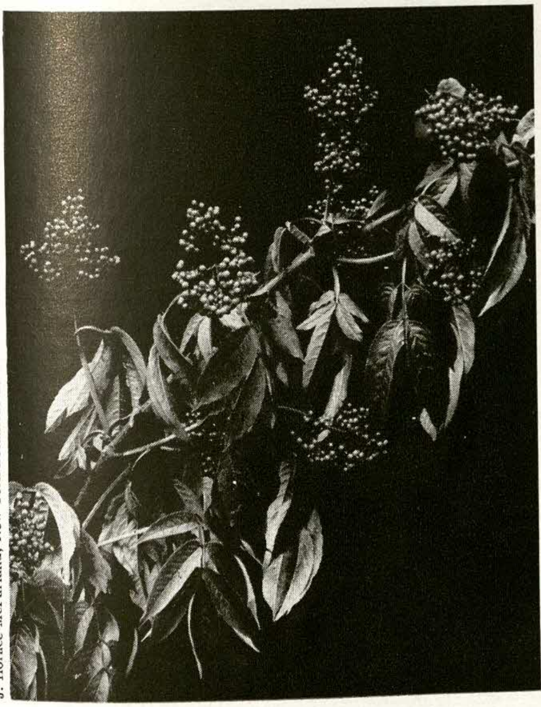
EL CANEY, BATTLE OF. See SPANISH-AMERICAN WAR (Land Battles).

EL CAPITAN. See YOSEMITE NATIONAL PARK (Rock Masses).

ELDER is an official of many Christian churches. See MORMONS (Church Organization); PRESBYTERIANS.

ELDER is a small tree or shrub of the honeysuckle family. Elders grow in many parts of the Northern Hemisphere. They have green leaves with finely cut edges, large clusters of small white flowers, and black, purple, or red berries. An elder found in Mexico and the southwestern part of the United States grows as tall as a tree.

American Elder Flowers, *left,* have five tiny, white petals. **Elderberries,** *below,* are a red, European variety.



J. Horace McFarland; New York Botanical Garden

Elder shoots contain pith which can be removed. Boys often hollow them out to make whistles and popguns. The ancient Greeks made a musical instrument called a *sambuke* from the elder stem.

Several other bushes and trees are called elder, but they do not belong to the honeysuckle family and are not true elders. The *poison elder* is a sumac, and the *box elder* is a maple. Many elderbushes and elder trees are planted in private grounds and gardens because they grow quickly and are hardy.

Scientific Classification. Elders belong to the family *Caprifoliaceae.* The common elder is genus *Sambucus,* species *canadensis.* J. J. LEVISON

ELDERBERRY. See ELDER.

EL DORADO, *EL doh RAH doh,* is the Spanish name for a legendary South American king who supposedly powdered his body with gold dust every morning and washed it off every evening in a lake. Spanish and English explorers searched for the rich kingdom of El Dorado, but never found it (see EXPLORATION AND DISCOVERY [Spanish]). The legend probably referred to a ceremony performed by a chief of the Chibcha Indians. He was sprinkled with gold dust and threw a sacrifice of gold into a lake. The term has become common for any legendary place of untold riches. B. A. BOTKIN

EL DORADO, Ark. (pop. 25,292; alt. 260 ft.), is the "oil capital" of Arkansas. It lies about 115 miles south of Little Rock. For location, see ARKANSAS (color map).

El Dorado was founded in 1843. It grew slowly until oil was discovered nearby in 1921. It is a soft-pine lumber center. The city has a mayor-council government, and is the seat of Union County.

ELEANOR OF AQUITAINE, *AK wih TAYN* (1122?-1204), was the queen of Louis VII of France and later of Henry II of England. She was the mother of two English kings, Richard the Lion-hearted, and John. France and England fought for many years over control of her vast French estates. She was a patron of troubadour poetry and of courtly love.

ELEATIC SCHOOL. See PARMENIDES.

ELECAMPANE, *ehl ee kam PAYN,* is a coarse plant closely related to the asters. In many parts of the United States and Canada it grows as a common roadside weed, but people once cultivated it widely.

Visual Education Service

The Elecampane Plant

The heavy, fleshy root of the elecampane has a bitter taste similar to that of camphor. Doctors use it to stimulate the organs of secretion. Elecampane is sometimes used as horse medicine, and is often called *horseheal.* Workers dig the roots in autumn of the second year, and clean, slice, and dry them. About 50,000 pounds of elecampane root is used in the United States each year.

Scientific Classification. Elecampane is a member of the family *Compositae.* It is classified as genus *Inula,* species *helenium.* HAROLD NORMAN MOLDENKE

ELECTION is the process by which voters choose their officers or policies in a government or organization. In a representative democracy such as the United States, voters elect national, state, county, and local officials. Members of many organized groups share in the selection of officers or policies for the group by the process of election. For example, stockholders usually elect the board of directors of a corporation. Labor union members may elect their union officials.

Elections and Democracy

The fundamental principle of representative government is that the people shall be governed by officers of their own choosing. This principle requires popular elections. In a truly representative democracy, all adults, except certain criminals and the mentally unfit, can vote. The democratic process also demands that citizens be permitted to vote secretly, in freedom from violence or threats. In modern democracies, political parties help the *electorate*, or the body of voters, select candidates for public office and set forth platforms.

One duty of citizens in a democracy is to take part in the work of government by voting at the polls. This function is as important as that of obeying the laws.

In the United States, the voters elect members of the national legislature, or congress. The President and Vice-President are chosen by *electors* elected by the voters. In each state, the voters elect the governor, other executive officers, and members of the state legislature. Most state elections are decided by a *plurality*, with one of several candidates having the highest number of votes being elected. State voters may also be called on to vote on special issues through a *referendum*, *initiative*, or *recall*. See Initiative and Referendum; Recall.

In the parliamentary system, such as in Great Britain and Canada, the people elect the legislature, or parliament. The prime minister, appointed by the head of state, is usually a leader of the party that has a majority in parliament. He serves as the chief executive. See Cabinet (Cabinet System of Government).

Elections and Dictatorship

In countries ruled by dictators, some public officials may be "elected" for propaganda purposes. But the people actually have no choice in such elections. Adolf Hitler retained popular election of the Reichstag, or legislature, in Germany. But he permitted only one political party, his own, to exist. In a dictatorship, the country's one political party selects all the candidates for office. The communist-controlled one-party elections in Russia are not free elections.

In the United States

Constitutional Provisions. The United States Constitution requires a congressional election every two years, to elect members of the House of Representatives for two-year terms and one third of the Senate for six-year terms. It also requires the election of presidential electors every four years. The electors in turn elect the President and Vice-President. All these elections are really state elections, regulated by the state legislatures, although the United States Constitution gives the U.S. Congress authority to change state regulations. Congress, by federal statute, has secured uniformity throughout the states by requiring that congressional elections be held on the Tuesday following the first Monday in November of every even-numbered year.

Each state constitution contains the requirements for offices, the times for the elections, and the qualifications of the voters. Other election details are usually left to state laws. Under state laws, three general kinds of elections are held: (1) for the nomination of candidates, (2) for the election of officers, and (3) popular votes on policy or other political measures.

Nomination of Candidates. In the early days of the republic, candidates for office were selected by the *caucus*, a secret meeting of party leaders. After 1820, conventions of political parties selected the candidates, whose names were then placed on the printed ballots.

The *direct primary* is based on the assumption that elections are on a party basis. That is, the candidates seeking nomination label themselves as Republicans, Democrats, or members of some other party and are so listed on the ballots. At the polls there are two kinds of ballots, one for Republicans and the other for Democrats, or more if other parties are represented. Each voter asks for the ballot he prefers.

"Raiding" the primaries has been a frequent political device. Members of one party will vote in the opposing party's primary to nominate a candidate whom they believe their own candidate can defeat. To prevent raiding, some states have adopted the *closed primary*. Every voter must register his party affiliation. At the primaries he may receive only the ballot of his party. Some states have developed the preprimary convention for party endorsement of candidates, and this endorsement usually appears on the primary ballots in states where it is permitted.

Millions of voters are independent, and shift their party allegiance in good faith from year to year. To meet this situation, several states have an *open primary*. At the polls, the voter may be given a *blanket ballot*, listing in separate columns the candidates of each party. In other cases he is handed several ballots one for each party. In this case he returns only one ballot, folded with the printed page inward, and discards the unused ballots in a separate closed box. In either case the voter votes without disclosing his party affiliation. Only in the state of Washington does the primary, known there as the *blanket primary*, permit the voter to split his choices between two parties on different offices.

Nonpartisan primaries have been introduced in some states, especially for judicial offices. They are used for other offices in many cities and some counties. In Minnesota and Nebraska, nonpartisan nomination is used for members of the legislature. No political affiliation of candidates is indicated on the ballots, and none is asked of the voters. The two candidates polling the highest and second highest number of votes for each office are designated as duly nominated. Their names will appear on the nonpartisan ticket used at the final election as the only candidates for the office. See Primary Election.

Election Procedure. The polls are held in a room of some designated building in each precinct. The hours and place are advertised in the local newspaper. In most states, the election officers in each polling place are appointed by local authorities, and must represent the two major parties. These precinct election officers vary in number among the states. Their titles, such as *judge of elections*, *clerk*, and *inspector*, differ not only among the states but also within polling places. The election officers check the voters' names against the registration list, hand out the ballots, and supervise the placing of the marked ballots in the ballot box.

On election day, the voter who has received his ballot from one of the election clerks carries it into a booth or screened compartment. There he marks the ballot, undisturbed. Then he returns to the clerk's table and the folded ballot is deposited in the ballot box. If a voting machine is used in his precinct, however, a paper ballot is not usually used. See VOTING.

The polls are generally open from early in the morning until evening. After the closing of the polls, the election officials tabulate, or count, the votes given to each candidate. After this count, all ballots, including all defective ballots, are returned to the ballot box, together with the poll books and tally sheets. These boxes are sent, under seal, to the city or county clerks, to the board of election, or, in some states, to a canvassing board. In a few places, central counting boards have been established, and ballot boxes are moved there from precincts before counting. The returns of all state and national elections are filed with the secretary of state of each state. State or local officials, as appropriate, issue a certificate of election to each candidate elected to office.

Every state has statutes defining corrupt election practices and providing severe penalties for them. In most states, law-enforcement officers have the duty of prosecuting any election frauds. FRANKLIN L. BURDETTE

Related Articles in WORLD BOOK include:

Ballot
Campaign
Campaign Funds
Corrupt Practices
Election Day
Electoral College
Political Party
Primary Election
Proportional Representation
Recall
Voting

ELECTION DAY in the United States is the day on which national elections for presidential electors take place. Congress established the first Tuesday after the first Monday in November as Election Day. It is a legal holiday in most states and in all territories. Many state elections are also held on this day. Most states forbid the retail sale of liquor while the polls are open.

Originally Congress did not set a specific date for national elections. Each state could appoint its electors on any day within 34 days before the first Wednesday in December, the date set for the convening of electors. In 1845 Congress established the present Election Day to correct abuses that arose because of the lack of a uniform election day. RAYMOND HOYT JAHN

ELECTIVE SYSTEM. See EDUCATION, HISTORY OF (Expanding Courses of Study).

ELECTOR, GERMAN IMPERIAL. See HOLY ROMAN EMPIRE.

ELECTORAL COLLEGE, *ee LEHK tur ul*. The United States Constitution provides that the President shall be elected by a body of presidential electors chosen by all the states. This body is the Electoral College.

Every state has as many votes in the Electoral College as the total of its Senators and Representatives in Congress. The chart on the next page shows how the size of the college has changed. It also shows how each state has voted since 1804, when the present system of electing the President was adopted. Candidates for presidential electors in each state generally are selected by state committees or conventions of each political party. Their names may or may not appear on the ballot with the names of candidates for President and Vice-President. Many voters thus do not realize they do not vote directly for the President and Vice-President. In the November presidential election, a presidential candidate usually receives all or none of the electoral votes of a state, depending on his winning a *plurality*, or the highest number of the state's popular vote.

The College in Action. In the December following the presidential election, on a day set by law, the duly elected presidential electors in each state assemble, usually at the state capital. There, they formally cast their ballots for President and Vice-President. Either by custom or, in a few states, by law, electors vote for their party's choices for the two offices. The lists of these elections are sent under seal to the president of the United States Senate and to the Administrator of General Services in Washington, D.C. In January, at a joint session in the House of Representatives, the president of the Senate opens the certificates. Then four tellers, one Democrat and one Republican from each house, count the votes in the presence of both houses of Congress. The candidate receiving the highest number of electoral votes for President is declared elected, provided that the number is a majority of the electors. If no candidate has a majority, the state delegations in the House of Representatives choose the President. Each state has only one vote in such an election. The Senate elects the Vice-President, if no candidate wins that office in the Electoral College, from the two candidates having the highest number of electoral votes.

Reasons for the Electoral College. The manner of electing the President was one of the troublesome problems of the Constitutional Convention of 1787. The convention rejected the proposal that the Chief Executive be elected by Congress, on the grounds that he would then be under the control of the legislature. The proposal that the people elect the President also was rejected.

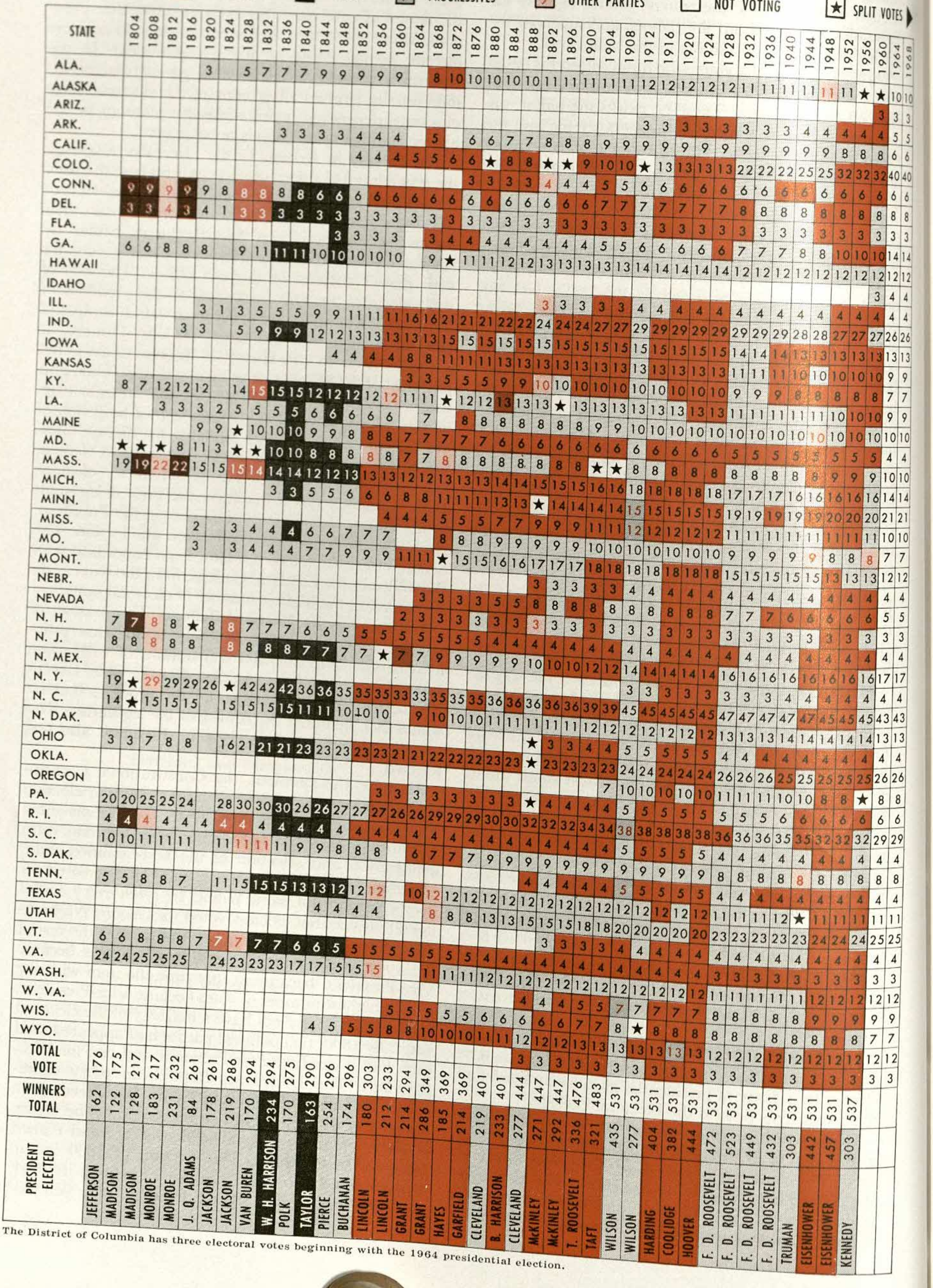
To solve this problem, the Constitutional Convention agreed on the method of indirect popular election which became the Electoral College. The Fathers of the Constitution hoped this procedure would promote calm deliberation and selection of the best-qualified man.

History. From 1789 to 1801, each elector voted for two persons on the same ballot. In 1789, every one of the 69 presidential electors voted for George Washington. Thirty-four voted for John Adams, and the rest of the votes were for other candidates. Adams became Vice-President, because at that time the man with the second highest number of votes became Vice-President, even though he did not have a majority of the electoral votes. By 1800, two political parties had appeared, and each had a candidate for President and one for Vice-President. The Democratic-Republican party candidates, Thomas Jefferson and Aaron Burr, received a majority of the votes and tied for election. The House of Representatives had to break this tie, and named Jefferson as President. The election of 1800 led to Amendment 12 to the Constitution, ratified in 1804, providing that electors should designate their votes for

ELECTORAL COLLEGE

The chart, *below*, shows how the electors of each state have voted since 1804, when the present system of electing the President became law. The House of Representatives decided the 1824 election because no candidate had an electoral majority. In 1872, the electoral votes of Arkansas and Louisiana were disputed and not counted.

7 DEMOCRAT
7 REPUBLICAN
7 FEDERALIST
7 NAT. REP.
7 WHIG
7 PROGRESSIVES
7 OTHER PARTIES
☐ NOT VOTING
★ SPLIT VOTES ▶



STATE	1804	1808	1812	1816	1820	1824	1828	1832	1836	1840	1844	1848	1852	1856	1860	1864	1868	1872	1876	1880	1884	1888	1892	1896	1900	1904	1908	1912	1916	1920	1924	1928	1932	1936	1940	1944	1948	1952	1956	1960	1964	1968
ALA.					3		5	7	7	7	9	9	9	9	9		8	10	10	10	10	10	11	11	11	11	11	12	12	12	12	12	11	11	11	11	11	11	★	★	10	10
ALASKA																																								3	3	3
ARIZ.																												3	3	3	3	3	3	3	3	4	4	4	4	4	5	5
ARK.									3	3	3	3	4	4	4		5		6	6	7	7	8	8	8	9	9	9	9	9	9	9	9	9	9	9	9	8	8	8	6	6
CALIF.													4	4	4	5	5	6	6	★	8	8	★	★	9	10	10	★	13	13	13	13	22	22	22	25	25	32	32	32	40	40
COLO.																			3	3	3	3	4	4	4	5	5	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
CONN.	9	9	9	9	9	8	8	8	8	8	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	7	7	7	7	7	7	7	8	8	8	8	8	8	8	8	8	8
DEL.	3	3	4	3	4	1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
FLA.												3	3	3	3		3	4	4	4	4	4	4	4	4	5	5	6	6	6	6	6	7	7	7	8	8	10	10	10	14	14
GA.	6	6	8	8	8		9	11	11	11	10	10	10	10	10		9	★	11	11	12	12	13	13	13	13	13	14	14	14	14	14	12	12	12	12	12	12	12	12	12	12
HAWAII																																								3	4	4
IDAHO																							3	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
ILL.					3	1	3	5	5	5	9	9	11	11	11	16	16	21	21	21	22	22	24	24	24	27	27	29	29	29	29	29	29	29	29	28	28	27	27	27	26	26
IND.				3	3		5	9	9	9	12	12	13	13	13	13	13	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	14	14	14	13	13	13	13	13	13	13
IOWA												4	4	4	4	8	8	11	11	11	13	13	13	13	13	13	13	13	13	13	13	13	11	11	11	10	10	10	10	10	9	9
KANSAS																3	3	5	5	5	9	9	10	10	10	10	10	10	10	10	10	10	9	9	9	8	8	8	8	8	7	7
KY.	8	7	12	12	12		14	15	15	15	12	12	12	12	12	11	11	★	12	12	13	13	13	★	13	13	13	13	13	13	13	13	11	11	11	11	11	10	10	10	9	9
LA.			3	3	3	2	5	5	5	5	6	6	6	6	6		7		8	8	8	8	8	8	8	9	9	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
MAINE					9	9	★	10	10	10	9	9	8	8	8	7	7	7	7	7	6	6	6	6	6	6	6	6	6	6	6	6	5	5	5	5	5	5	5	5	4	4
MD.	★	★	★	8	11	3	★	★	10	10	8	8	8	8	8	7	7	8	8	8	8	8	8	8	8	★	★	8	8	8	8	8	8	8	8	8	8	9	9	9	10	10
MASS.	19	19	22	22	15	15	15	14	14	14	12	12	13	13	13	12	12	13	13	13	14	14	15	15	15	16	16	18	18	18	18	18	17	17	17	16	16	16	16	16	14	14
MICH.									3	3	5	5	6	6	6	8	8	11	11	11	13	13	★	14	14	14	14	15	15	15	15	15	19	19	19	19	19	20	20	20	21	21
MINN.															4	4	4	5	5	5	7	7	9	9	9	11	11	12	12	12	12	12	11	11	11	11	11	11	11	11	10	10
MISS.					2		3	4	4	4	6	6	7	7	7			8	8	8	9	9	9	9	9	10	10	10	10	10	10	10	9	9	9	9	9	8	8	8	7	7
MO.					3		3	4	4	4	7	7	9	9	9	11	11	★	15	15	16	16	17	17	17	18	18	18	18	18	18	18	15	15	15	15	15	13	13	13	12	12
MONT.																							3	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
NEBR.																	3	3	3	3	5	5	8	8	8	8	8	8	8	8	8	8	7	7	7	6	6	6	6	6	5	5
NEVADA																2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
N. H.	7	7	8	8	★	8	8	7	7	7	6	6	5	5	5	5	5	5	5	5	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
N. J.	8	8	8	8	8		8	8	8	8	7	7	7	7	★	7	7	9	9	9	9	9	10	10	10	12	12	14	14	14	14	14	16	16	16	16	16	16	16	16	17	17
N. MEX.																												3	3	3	3	3	3	3	3	4	4	4	4	4	4	4
N. Y.	19	★	29	29	29	26	★	42	42	42	36	36	35	35	35	33	33	35	35	35	36	36	36	36	36	39	39	45	45	45	45	45	47	47	47	47	47	45	45	45	43	43
N. C.	14	★	15	15	15		15	15	15	15	11	11	10	10	10		9	10	10	10	11	11	11	11	11	12	12	12	12	12	12	12	13	13	13	14	14	14	14	14	13	13
N. DAK.																							★	3	3	4	4	5	5	5	5	5	4	4	4	4	4	4	4	4	4	4
OHIO	3	3	7	8	8		16	21	21	21	23	23	23	23	23	21	21	22	22	22	23	23	★	23	23	23	23	24	24	24	24	24	26	26	26	25	25	25	25	25	26	26
OKLA.																											7	10	10	10	10	10	11	11	11	10	10	8	8	★	8	8
OREGON															3	3	3	3	3	3	3	3	★	4	4	4	4	5	5	5	5	5	5	5	5	6	6	6	6	6	6	6
PA.	20	20	25	25	24		28	30	30	30	26	26	27	27	27	26	26	29	29	29	30	30	32	32	32	34	34	38	38	38	38	38	36	36	36	35	35	32	32	32	29	29
R. I.	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5	5	4	4	4	4	4	4	4	4	4	4
S. C.	10	10	11	11	11		11	11	11	11	9	9	8	8	8		6	7	7	7	9	9	9	9	9	9	9	9	9	9	9	9	8	8	8	8	8	8	8	8	8	8
S. DAK.																							4	4	4	4	4	5	5	5	5	5	4	4	4	4	4	4	4	4	4	4
TENN.	5	5	8	8	7		11	15	15	15	13	13	12	12	12		10	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	11	11	11	12	★	11	11	11	11	11
TEXAS												4	4	4	4			8	8	8	13	13	15	15	15	18	18	20	20	20	20	20	23	23	23	23	23	24	24	24	25	25
UTAH																								3	3	3	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
VT.	6	6	8	8	8	7	7	7	7	7	6	6	5	5	5	5	5	5	5	5	4	4	4	4	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3
VA.	24	24	25	25	25		24	23	23	23	17	17	15	15	15			11	11	11	12	12	12	12	12	12	12	12	12	12	12	12	11	11	11	11	11	12	12	12	12	12
WASH.																							4	4	4	5	5	7	7	7	7	7	8	8	8	8	8	9	9	9	9	9
W. VA.																5	5	5	5	5	6	6	6	6	6	7	7	8	★	8	8	8	8	8	8	8	8	8	8	8	7	7
WIS.												4	5	5	5	8	8	10	10	10	11	11	12	12	12	13	13	13	13	13	13	13	12	12	12	12	12	12	12	12	12	12
WYO.																							3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
TOTAL VOTE	176	175	217	217	232	261	261	286	294	294	275	290	296	296	303	233	294	349	369	369	401	401	444	447	447	476	483	531	531	531	531	531	531	531	531	531	531	531	531	537		
WINNERS TOTAL	162	122	128	183	231	84	178	219	170	234	170	163	254	174	180	212	214	286	185	214	219	233	277	271	292	336	321	435	277	404	382	444	472	523	449	432	303	442	457	303		
PRESIDENT ELECTED	JEFFERSON	MADISON	MADISON	MONROE	MONROE	J. Q. ADAMS	JACKSON	JACKSON	VAN BUREN	W. H. HARRISON	POLK	TAYLOR	PIERCE	BUCHANAN	LINCOLN	LINCOLN	GRANT	GRANT	HAYES	GARFIELD	CLEVELAND	B. HARRISON	CLEVELAND	McKINLEY	McKINLEY	T. ROOSEVELT	TAFT	WILSON	WILSON	HARDING	COOLIDGE	HOOVER	F. D. ROOSEVELT	F. D. ROOSEVELT	F. D. ROOSEVELT	F. D. ROOSEVELT	TRUMAN	EISENHOWER	EISENHOWER	KENNEDY		

The District of Columbia has three electoral votes beginning with the 1964 presidential election.

SPLITS IN ELECTORAL VOTES

All electoral votes from a state usually go to the candidate receiving the highest number of that state's popular vote. But in some elections, presidential electors have split their votes among two or more candidates. This is shown by a star (★) in the *Table* on the opposite page. Since 1804, the following splits in electoral votes have occurred:

Election	Total Vote and Split
1804	Md. 11 (Jefferson 9, Pinckney 2)
1808	Md. 11 (Madison 9, Pinckney 2); N.Y. 19 (Madison 13, Clinton 6); N.C. 14 (Madison 11, Pinckney 3)
1812	Md. 11 (Madison 6, Clinton 5)
1820	N.H. 8 (Monroe 7, J. Q. Adams 1)
1828	Me. 9 (J. Q. Adams 8, Jackson 1); Md. 11 (J. Q. Adams 6, Jackson 5); N.Y. 36 (Jackson 20, J. Q. Adams 16)
1832	Md. 8 (Clay 5, Jackson 3)
1860	N.J. 7 (Lincoln 4, Douglas 3)
1872	Ga. 8; Ky. 12; Mo. 15 (all for candidates other than regular Democratic and Republican)
1880	Calif. 6 (Hancock 5, Garfield 1)
1892	Calif. 9 (Cleveland 8, B. Harrison 1); Mich. 14 (B. Harrison 9, Cleveland 5); N.D. 3 (Cleveland 1, B. Harrison 1, others 1); Ohio 23 (B. Harrison 22, Cleveland 1); Ore. 4 (B. Harrison 3, others 1)
1896	Calif. 9 (McKinley 8, Bryan 1); Ky. 13 (McKinley 12, Bryan 1)
1904	Md. 8 (Parker 7, T. Roosevelt 1)
1908	Md. 8 (Bryan 6, Taft 2)
1912	Calif. 13 (T. Roosevelt 11, Wilson 2)
1916	W.Va. 8 (Hughes 7, Wilson 1)
1948	Tenn. 12 (Truman 11, others 1)
1956	Ala. 11 (Stevenson 10, others 1)
1960	Ala. 11 (Kennedy 5, others 6); Okla. 8 (Nixon 7, others 1)

President and Vice-President on separate ballots. A candidate must have a majority of the electoral votes to be elected Vice-President.

According to the United States Constitution, each state legislature determines the way in which that state's electors shall be chosen. At first, most states allowed their legislatures to choose the electors. But after 1800, more and more states began choosing electors in popular elections. Today all states use this method.

The development of political parties over the years has reduced the Electoral College to a routine ceremony. Each elector has made an implied pledge to vote in the Electoral College for his party's nominees, instead of voting for the candidate he personally thinks is best qualified for the office. This implied pledge has seldom been broken.

Frequent proposals have been offered for abolishing the Electoral College and for the direct election of the President by the people. These amendments would tend to reduce the importance of the states in the federal system of government. It has been claimed that direct election might encourage third and fourth parties. But this, in turn, might frequently result in the election of a President who received only a minority of the popular votes cast. William G. Carleton

Related Articles. See the separate biography on each President of the United States for information on the presidential elections. Other related articles in World Book include:

Electoral Commission
Electoral Count Act
President of the United States
Primary Election
United States Constitution (Article II; Amendment 12)
Vice-President of the United States

ELECTORAL COMMISSION was a group created by Congress in 1877 to decide who won the presidential election. Both Republicans and Democrats claimed to have won. Samuel J. Tilden, the Democratic candidate, had 184 electoral votes, or one short of a majority in the Electoral College. Rutherford B. Hayes, the Republican candidate, had 165 votes. Twenty votes were disputed, 19 of them from Florida, Louisiana, and South Carolina, where Reconstruction had not yet run its course (see Reconstruction). Each of these states sent two conflicting sets of election returns to Washington. The other disputed vote came from Oregon, where eligibility of one Republican elector had been questioned and a certificate of election had been issued to his rival. As a matter of policy, the Democrats automatically questioned the results of each election board.

To settle the matter, Congress created the Electoral Commission. It was made up of 15 members: five Senators, five Representatives, and five Supreme Court justices. Congress carefully arranged that three senators and two representatives were to be Republicans, while two senators and three representatives were to be Democrats. Of the justices, two Democrats and two Republicans were named, and these four had power to choose a fifth. They would probably have chosen David Davis of Illinois, an independent in politics. But his decision to accept election to the United States Senate left only Republican justices from whom to choose. As a result, the commission had a Republican majority of eight to seven. By a strict party vote, the commission gave every one of the disputed votes, and the election, to Hayes. Some Republicans, including Hayes himself, felt that if Southern Negroes had dared to vote, the election would not have been in doubt. John D. Hicks

See also Electoral College; Electoral Count Act; Hayes, Rutherford Birchard (Campaign of 1876); Tilden, Samuel Jones.

ELECTORAL COUNT ACT of 1887 provides that disputes concerning the election of presidential electors shall be settled by an authority designated for that purpose by the state. If, for any reason, two or more conflicting returns are sent to Washington, D.C., from the state, then the two houses of Congress shall vote separately on the question. If they disagree, the returns certified by the state's governor are to be accepted. If the governor does not certify one of the returns, the state loses its electoral vote in the election.

ELECTRA. See Pleiades.

ELECTRA, *ee LEK truh,* in Greek legend, helped avenge the murder of her father, Agamemnon. She saved her brother, Orestes, from death when her mother, Clytemnestra, and Aegisthus killed her father. She sent Orestes to safety in Phocis. Electra hated her mother. For seven years she lived with her and Aegisthus in the palace at Argos, waiting until Orestes would be old enough to come back and punish them. They treated her badly because she would not approve the murder. Orestes came back in disguise and made himself known to Electra. She helped him plot the murderers' death and carry out the plot. Later, she married Orestes' friend, Pylades. Joseph Fontenrose

See also Agamemnon; Clytemnestra; Orestes.

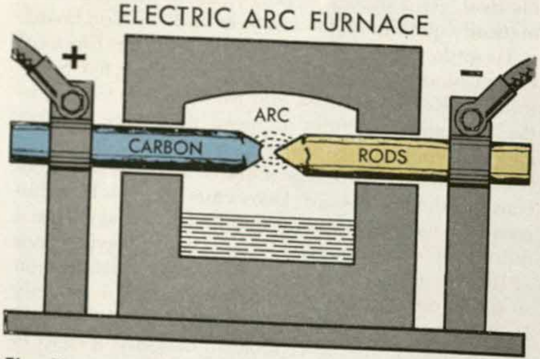
ELECTRIC APPLIANCE. See Appliances.

ELECTRIC ARC is a luminous flame of electricity which leaps from one conductor to another. It seems to be leaping, or *arcing*, across the space without a conductor, but actually the gases in the air serve as conductors. The two conductors between which the arc flows are called *electrodes*. The electric-arc principle has had many uses, not only in industrial arc welding but also in lighting.

The electric arc was discovered by Sir Humphry Davy about 1808 (see DAVY, SIR HUMPHRY). The arc occurs because the electric potential difference between the electrodes is sufficient to break down, or *ionize*, the air between them, and this ionized air or gas conducts electric current. In doing so it produces a flame. This flame is called an arc because it is curved like the arc of a circle, as it forms between the two electrodes. The length of the arc is determined by its voltage. It must be short, to avoid oxidation and to prevent the inclusion of any harmful gases. When the air is ionized, it is broken up into electrons and positive *ions*. The positive ions move away from the positive electrode, or *anode*. The electrons flow away from the negative electrode, which is known as the *cathode*. Most electric arcs are not self-starting. The cathode and anode must be brought together before the current will arc across. One of the most common uses of the electric arc is in the process of arc welding.

PALMER H. CRAIG and ELMER C. EASTON

See also ARC LIGHT; ELECTRIC FURNACE; ELECTRODE; WELDING.



The Electric Arc is used in industrial furnaces for heating metals. It is also commonly used in arc lights.

ELECTRIC AUTOMOBILE. See ELECTRIC CAR.

ELECTRIC BATTERY. See BATTERY; HYDROMETER.

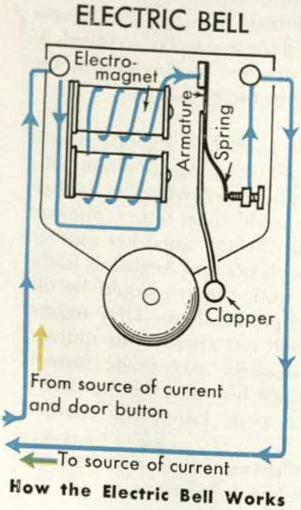
ELECTRIC BELL. The most common type of electric bell is the doorbell found in apartments and homes. The button at the door is connected by wires to the electric circuit that operates the bell. One wire from the source of the current runs through the push button to an electromagnet and an armature. A clapper for striking the bell is attached to the end of the armature. Also attached is a spring that presses against a screw. A second wire runs from the screw back to the source of current, and completes the circuit. When someone presses the button at the door, he completes the electrical circuit. The current goes down one wire to the electromagnet. When current flows through the electromagnet, it attracts the metal clapper, which strikes the bell. But when the spring moves away from the screw, the circuit is broken, and the armature is released from the electromagnet. It moves back to its original position, where the spring comes in contact with the screw and completes the circuit again. The clapper strikes the bell again. The bell will keep ringing as long as someone presses the button.

Any number of bells can be rung by the same push button if they are connected with the same circuit. Burglar and fire alarms, and school and factory bells, are all based on the same general principles.

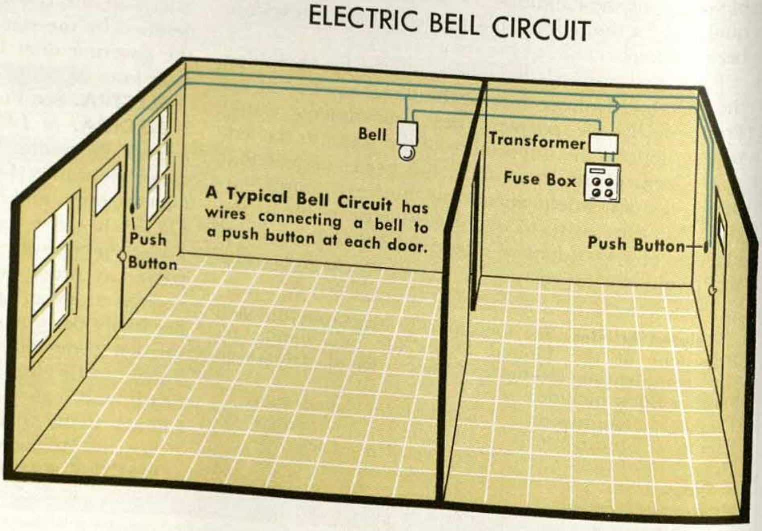
The source of the electricity may be either a dry-cell battery or a bell-ringing transformer that connects to the electrical system of the house. The advantage of a dry cell is that it provides an independent source of power. It can therefore be used anywhere. The disadvantage is that it wears out. A transformer is more dependable than a dry cell, because it does not wear out under normal use. Most bells use transformers.

When an electric bell is out of order, the trouble is often caused by a weak battery. Sometimes the screw is not touching the armature spring correctly.

An electric gong that strikes only once when the



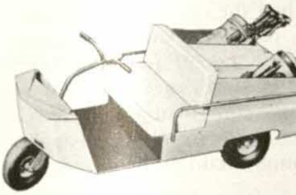
How the Electric Bell Works



A Typical Bell Circuit has wires connecting a bell to a push button at each door.

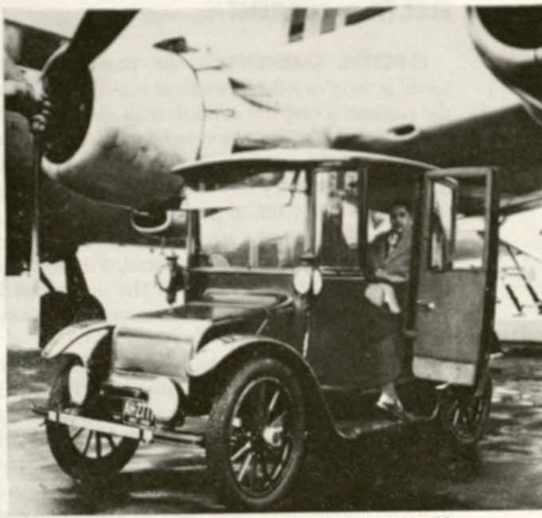
Popular Science Monthly

Modern Electric Cars are designed to go over 55 mph, and have a range of 80 miles.



Victor Adding Machine Co.

Golf Carts operate like the old electric cars, and carry golfers and their equipment.



Popular Science Monthly

Early Electric Cars developed from 2 to 5 horsepower, and reached a speed of 20 miles an hour. Their batteries had to be recharged about every 50 miles.

ELECTRIC CAR

button is pressed can be made by connecting the armature through a flexible wire to the screw. This causes the current to flow, even though the spring moves away from the screw. Electric gongs are larger than ordinary electric bells. RAYMOND F. YATES and ELMER C. EASTON

ELECTRIC BLANKET is a blanket through which flexible heating coils have been threaded. Manufacturers make electric blankets of wool or of any natural or synthetic fiber. They thread the heating coils throughout the interior sections. Temperature controls are attached to these coils. Persons who use electric blankets can regulate the temperature of the blanket by means of a switch. The blankets come in various sizes. Large ones often have two controls, to allow different temperatures in each half of the blanket. SAMUEL SEELY

ELECTRIC CAR is a passenger vehicle that receives its power from an electric motor. Electric cars were most popular during the early period of the automobile, between the late 1890's and 1910. They were easy to operate, quiet, and clean. The early gasoline-driven cars did not start easily and required a great deal of mechanical skill to operate. The driver of the electric car merely operated the *controller*, or speed regulator, and steered, since the car had no gears to shift.

How Electric Cars Worked. The typical electric car received its power from a single, 2- to 5-horsepower motor. Lead-acid batteries were the usual source of power. The transmission usually consisted of a drive shaft from the motor to the rear wheels. Some cars used chain drives. The electric car reached a top speed of 20 miles an hour, and could rarely travel more than 50 miles without changing or recharging the battery.

Gas-electric cars attempted to provide a ready source of power. A small gasoline engine drove a generator, which supplied the current either directly to the motor or to a set of batteries. Gas-electric cars had an almost unlimited cruising range, and eliminated the problem of caring for a number of storage batteries. But it cost a great deal to buy the car and maintain the engine and the generator. At one time, the gas electric system was a widespread source of power for trucks.

History. Many of the early experiments with electric vehicles took place in Europe in the late 1880's. An electric cart built in 1887 used a 16-cell battery to power the motor. The cart used a chain drive, and could reach a speed of about 9 miles an hour. The first commercially successful electric car was built in 1893. It used a 54-cell battery and seated six persons.

In the United States, electric cars were modeled on those of Europe. One of the most famous American cars was the *Electrobat*. In 1895, it won a race from the famous gasoline-powered car owned by the Duryea brothers. By the late 1800's, electric cars were being produced commercially, and by 1900, 300 electric taxicabs were operating in New York City. Between 1896 and 1928, there were 54 manufacturers of electric cars. Between 1896 and 1915, approximately 35,000 of these vehicles were built in the United States.

The popularity of the electric car faded rapidly after 1910. By this time, the gasoline-powered automobile showed itself to be superior to the electric car in almost every way. One of the chief disadvantages of the gasoline car was that it had to be hand cranked. But the invention of an electric starter eliminated this difficult task. Compared to the new gasoline cars, the electric car was slow and had a limited driving range. Its batteries were expensive to replace and difficult to maintain. Gasoline cars also offered a more attractive styling and design. Manufacturers stopped producing electric cars commercially on a large scale in 1928, but one company continued to build them on special request until World War II. In the 1950's, public interest in electric cars again revived, and some manufacturers began producing them on a limited scale. J. H. WHITE

See also AUTOMOBILE (The Electric Car).

ELECTRIC CATFISH. See ELECTRIC FISH.

ELECTRIC CHAIR. See ELECTROCUTION.

ELECTRIC CIRCUIT. See ELECTRIC CURRENT.

ELECTRIC CURRENT

ELECTRIC CURRENT is the passage of electricity along a wire or other electrical conductor. It is due to the passage along the conductor of electrons, which are little particles of matter revolving about the center of every atom. They carry a negative charge of electricity, and are attracted by matter with a positive charge. The rest of the atom has a positive charge that holds the electron in the atomic structure. When an atom's positive and negative charges are equal, the atom is neutral. But if something breaks down the atom and frees an electron, the electron will then move toward some other positive charge.

According to the theories of Weber, Drude, and Lorentz, metals contain "free" electrons, that is, electrons free to move about among the atoms. The drift of these free electrons, caused by an applied electric field, produces an electric current. However, modern physical theory indicates that this is only part of the story, and that moving electrons have 'waves" associated with them.

The force with which electricity is moved is called *electromotive force*. Electric waves flow at the tremendous speed of approximately 186,000 miles a second. Electrons move through a wire very slowly, since their passage through a conductor is partially blocked by a phenomenon similar to friction, called *electrical resistance*. The greater the resistance, the smaller the current which can pass through. Electric current, when it encounters resistance, gives rise to *heat*.

The resistance of a conductor is measured in *ohms*. The electromotive force is measured in *volts* and the current is measured in *amperes*.

Electric current is really a form of energy. Of itself, it does not help us much. It must be changed into some other type of energy. In the case of electric toasters and irons, most of the energy changes to heat. If the voltage forces the current through an electric motor, the electrical energy is changed into mechanical energy. In the case of an electric light, the electrical energy is changed into light. In charging a storage battery, the electrical energy is changed to chemical energy.

When a source of electromotive force is applied to a conductor, the conductor is said to have a difference in *potential energy* between its ends. This is called *potential difference*. When the potential difference is high, the electromotive force is great, and the current is increased.

Conductors

All materials conduct electricity. But some materials, such as rubber and glass, allow so few electrons to get through that the current is hardly noticeable. These materials are called *insulators*. Other materials, such as metals, conduct current readily. These materials are called *conductors*. Metal, in general, is the best conductor, and silver, copper, gold, and aluminum are among the best metallic conductors. Copper wire is used to carry most currents because it is the least expensive of the good conductors. However, the copper must be pure, because even small amounts of other metals alloyed with the copper affect its efficiency in carrying a current. Current is sometimes carried by a conductor made up of silver dust printed on an electrical device. The fact that metals conduct electricity while rubber does not is thought to be due to their relative numbers of free electrons. The electrons of rubber are fixed rigidly to their atoms, whereas some of the electrons of the atoms of a metal can move about more freely.

Electric Circuits

The path along which the current flows from start to finish is called a *circuit*. The circuit includes the generator that starts the current, the wires, and any electrical device that the current operates, such as an electric light or a refrigerator. If any part of the circuit is removed, such as a wire or a connection between the wires, the current cannot flow. The circuit is then said to be *broken*, or *opened*. When the connection is made again, the circuit is *made*, or *closed*. An electric light switch opens and closes the circuit (see ELECTRIC SWITCH). A *circuit breaker* is a device that opens a circuit automatically when the current grows too strong. This may be necessary when too many electrical appliances are running on the same circuit at the same time (see CIRCUIT BREAKER).

At ordinary power frequencies, the beginning of the circuit, where the current starts, and the end of the circuit, where the current ends, must be in some kind of contact. If you attached one end of a wire to one of the poles on a battery, and the other end of the wire to a light, nothing would happen. The wire must be attached to the light and then run past it back to the other pole of the battery. Then the circuit is complete and a current can flow. The light will go on. In *very* high frequency circuits, however, current can flow when there is no apparent connection, because a small electrical condenser, or *capacitor*, is formed between adjoining conductors, and at high frequencies current can flow through such a capacitor.

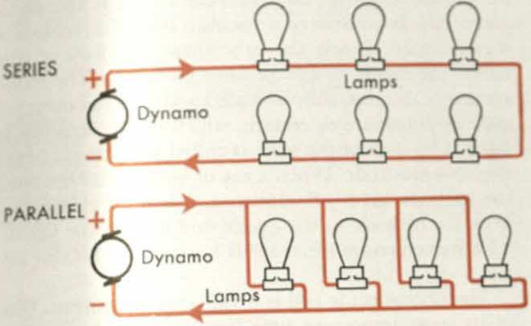
The battery or generator acts as a sort of pump for the current. Much as a water pump creates water pressure by a vacuum, the battery creates electromotive force by chemical action.

When the circuit includes several electrical devices, such as a number of lamps, it is either a *series circuit*, or a *parallel circuit*. In a series circuit, the lamps are connected together by a single wire. The current must pass through each to reach the next one. In a parallel circuit the current branches out from the main line to each unit, and then back to the main line. Battery connections in a series circuit run from the positive pole of each battery to the negative pole of the next battery. In a parallel circuit, there are two wires. One connects all the negative poles, and the other all the positive.

In a series circuit, the resistance of all the units is equal to the total resistance of the circuit. For example, suppose a force of 120 volts is applied to a lamp that offers 40 ohms resistance, in series with another lamp that offers 20 ohms resistance. The series arrangement has a total of 60 ohms resistance. Ohm's Law states that the current equals the voltage divided by the resistance ($E=IR$). Hence the current in this example equals 120 volts divided by 60 ohms, or 2 amperes. The more units that are added to the circuit, the greater the resistance and the weaker the electrical current becomes.

In a parallel circuit, the total resistance is actually decreased when new units are added. For example, if a 12-volt force is applied to two lamps of 4 ohms resistance each, the total resistance will be 2 ohms, and the

TYPES OF ELECTRIC CIRCUITS



Series and Parallel Circuits Are Opposite in Principle.

current drawn from the battery will be 12 divided by 2, or 6 amperes. Through each lamp, however, 3 amperes will flow.

Direct and Alternating Current

Direct Current (D-C). All current does not flow continuously in the same direction. A *direct current* flows continuously in the same direction until the circuit is broken or the power fails. The magnitude of a direct current can vary but its direction does not vary. When alternating current is changed to direct current by means of a *rectifier*, the resulting direct current is often *pulsating*, which means that the magnitude of the direct current varies in pulses, corresponding to the frequency of the alternating current.

Direct current has many important uses in electric motors and generators. In automobiles, d-c generators supply the electrical energy needed to keep the storage battery fully charged, to start the ignition system, and to light the lights and play the radio. In industry, d-c motors are used in operations where the motor changes speeds quite often. For example, many d-c motors can be adjusted to operate at a certain speed and will continue to operate at that speed regardless of the size of the load the machine must carry. D-c motors are also used in electric locomotives and streetcar buses.

Alternating Current (A-C) changes the direction of its flow at periodic intervals called *cycles*. A cycle is one complete reversal of current. When 60 complete reversals occur each second, the electric current involved is referred to as a 60-cycle alternating current. The *frequency* of an alternating current is the number of cycles in a second.

Alternating current is more widely used than direct current for several reasons. Simpler generating machines and electric motors are possible with alternating current. For example, in direct current motors it is necessary to connect first one, then another of the coils of the rotating armature to the source of power, so that one after another of these coils can be made an electromagnet to act with the stationary poles (field poles) to cause the motor to rotate. This necessitates a switching arrangement known as a *commutator*. This is eliminated in a-c machines in favor of simple *slip rings*.

The biggest advantage of alternating current is that it can readily be transformed to high voltages. Since the main losses in electric power transmission increase as the square of the current, it is desirable to use high voltage and low current for power transmission. The simple and highly efficient *electric transformer* allows alternating current to be "stepped up" in voltage or "stepped down" at will, but this is not possible with direct current. Thus, alternating current can be sent long distances with much less loss of power than direct current. It can be sent from a power plant or a waterfall to a city many miles away with little power loss. Almost all the electrical power used in our homes is alternating current. Usually home current is 60-cycle, but some cities use 25-cycle and 50-cycle current. Sixty-cycle current is now becoming standard in the United States.

Most household appliances, such as vacuum cleaners, radios, and washing machines, use alternating current. But alternating current cannot be used to charge batteries or to electroplate materials. In this case, the current must be changed to direct current by means of a *rectifier*.

PALMER H. CRAIG and ELMER C. EASTON

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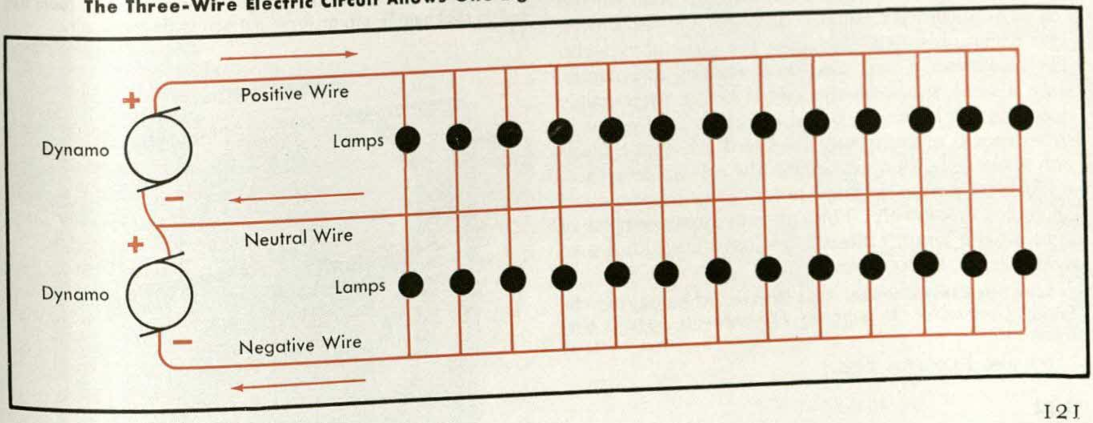


N.Y. Zoological Society

The Electric Eel of South America can generate enough electricity in its body to stun a horse or drive a small motor.

ELECTRIC EEL is a fish, related to carp and catfish, that can give a strong electric shock. It lives in the shallow, muddy waters of the Amazon and Orinoco rivers in South America. It is not a true eel, but its long, snaky body makes it look like one. Its head is flattened, and its eyes are far forward toward the mouth. But inside it is quite different from an eel. Most of its organs lie in the front fifth of its body. The other four fifths mainly hold the organs that make the electric current. The tissues of these organs consist of many layers built one behind another like the plates in a battery. The current they produce flows from the head to the tail.

Scientists think that certain swimming muscles in the electric eel's ancestors probably changed into the electric organs. The eels have three pairs of these organs. The largest pair runs almost to the tip of the tail. Under these lie two smaller pairs. The fish depends on the electric shock to catch food and to protect itself from enemies. It can detect objects at a distance under water by electricity. It is thought that the weak shocks from the smaller organs serve as a telegraph to other electric eels. The electricity usually damages the fish's eyes. This telegraph system may take the place of eyesight. The weak shocks may also be a warning to enemies, since a weak shock always comes before the stronger ones. When it becomes excited, the electric eel produces strong shocks in sets of three to five. Each impulse lasts only about $\frac{2}{1,000}$ of a second, but the eel can keep them up for a long time, perhaps hours. They usually reach about 200 or 300 volts. This can stun a man or horse or light a neon lamp. Unusual eels have been known to discharge 500 to 800 volts.

Scientific Classification. The electric eel belongs to the family *Gymnotidae*. It is genus *Electrophorus*, species *electricus*.

CARL L. HUBBS

See also ELECTRIC FISH.

ELECTRIC EYE is a device in which light generates an electric current. Its technical name is the *photoelectric cell*. It consists of a vacuum tube that looks like a radio tube. Inside the tube there is a loop of wire called the *anode*, or the positive electrode. The inside surface of the glass tube is coated with a metal material, such as potassium or cesium, which is very sensitive to light. This part of the tube is called the *cathode*, or the negative electrode. When a ray of light strikes the tube, the cathode gives off electrons. These electrons flow from the cathode to the anode and around the circuit. This movement of electrons is known as an *electric current*.

The photoelectric cell is a valuable instrument. One of its most important uses has been in the motion-picture industry. When sound is recorded in the film studio, each sound wave changes into a light wave. This means that every sound is recorded on the film strip in a different brightness of light. When the film is shown in the theater, the light on the sound track of the film is thrown against a photoelectric cell. The photoelectric cell changes the light rays to electric current. This current then passes through a loudspeaker and changes back to sound. The photoelectric cell is also used in television. Other industries have used the photoelectric cell in many automatic controls used to count articles, open doors, operate machines, and inspect goods.

RAYMOND F. YATES

See also BURGLAR ALARM; ELECTRONICS; MOTION PICTURE (Sound); SOLENOID.

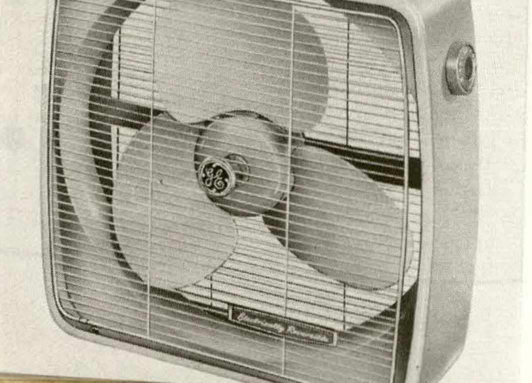
ELECTRIC FAN is a device used to circulate air or some other gas. The first fan was made in 1886 by Schuyler S. Wheeler (1860-1923), who placed a propeller on the end of a shaft which he turned with an electric motor. When the propeller revolved with the shaft, it pushed the air away and created an air current. All electric fans circulate air by means of propeller blades or turboblowers. The blades are connected to the motor shaft with belts. The most common electric fan is the one used in homes to create a breeze in hot weather. The motor draws power from the main circuit of the house. Exhaust fans are useful to draw cooking odors and gases out of kitchens. Industrial plants use large fans to draw out gases, dust, and hot air. Fans are used to clean grains, and for ventilation.

RAYMOND F. YATES

See also BLOWING MACHINE; ELECTRIC MOTOR; FAN; VENTILATION.

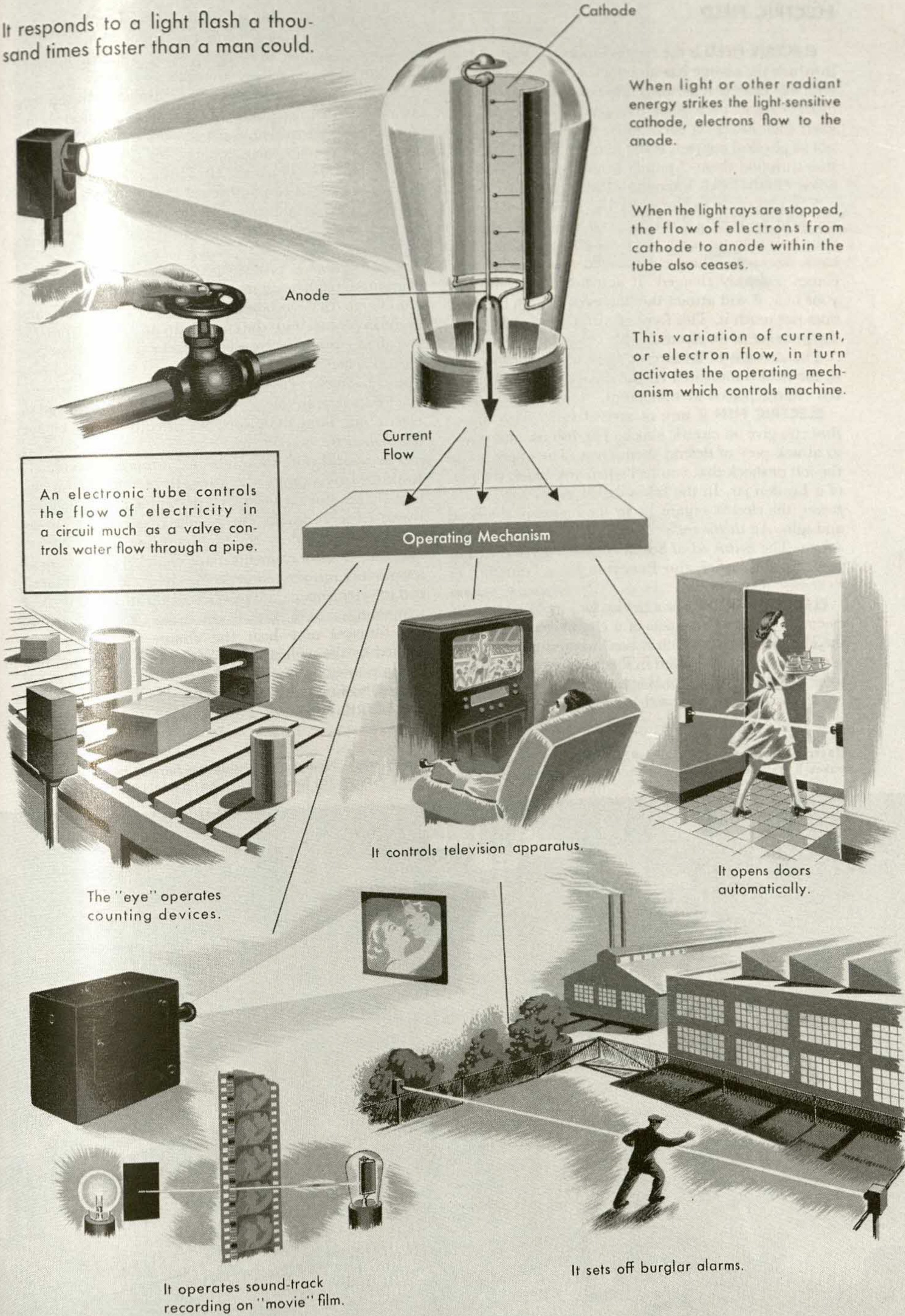
An Electric Portable Fan can be used to circulate room air, pull in cool outside air, or draw out hot, stuffy inside air.

General Electric Company



THE ELECTRIC EYE

It responds to a light flash a thousand times faster than a man could.



When light or other radiant energy strikes the light-sensitive cathode, electrons flow to the anode.

When the light rays are stopped, the flow of electrons from cathode to anode within the tube also ceases.

This variation of current, or electron flow, in turn activates the operating mechanism which controls machine.

An electronic tube controls the flow of electricity in a circuit much as a valve controls water flow through a pipe.

The "eye" operates counting devices.

It controls television apparatus.

It opens doors automatically.

It sets off burglar alarms.

It operates sound-track recording on "movie" film.

ELECTRIC FIELD is the region around a charged body in which the charge has an effect. For example, bodies with like charges repel each other and those with unlike charges attract each other. The fact that charged bodies exert such forces on each other, even though they are not in physical contact, is the result of the electric fields that surround them. Another way of saying this is that when electric fields interact, a force results.

You can easily demonstrate the presence of an electric field by briskly combing your hair. The atoms of your hair give up some electrons to the comb, so the comb becomes negatively charged and your hair becomes positively charged. If you hold the comb near your hair, it will attract the hair even though the comb does not touch it. This force of attraction demonstrates the presence of an electric field.

The strength of an electric field at any given point in the field is measured by the force it exerts on a unit test charge placed at that point.

Samuel Seely

ELECTRIC FISH is any of several fishes with organs that can give an electric shock. The fish use this power to attack prey or defend themselves. The effect is like the jolt or shock that you feel when you touch the pole of a Leyden jar. In the fishes called *electric rays*, or *torpedoes*, the electric organs lie in the region of the head and gills. An *electric catfish* lives in the rivers of tropical Africa. The *electric eel* of South America gives the most powerful shock. See also Electric Eel; Torpedo, or Electric Ray.

Leonard P. Schultz

ELECTRIC FURNACE is a device for providing heat by electrical means. It consists of a chamber that receives the electric current, which is used to raise the temperature of the materials placed in the furnace. The material to be heated is called the *charge*.

Electric furnaces are used to heat materials to great temperatures in order to produce useful products. For example, heat is used to melt different metals so that they can combine to form an alloy. Electric furnaces are also used to improve the quality of steel and glass by heating and cooling them at controlled temperatures below the melting point. Special types of electric furnaces vulcanize rubber, mold plastic, and dry and bake various other materials.

The chamber of an electric furnace is usually lined with a brick that can withstand high temperatures. An insulating material is usually used to surround the brick to keep in the heat. A protective shell covers the insulation.

Resistor furnaces provide heat by passing an electric current through resistance heating coils that surround the charge. In a *resistance furnace*, the electrodes actually come in contact with the charge. In an *induction furnace*, the charge is heated by electric induction, without any electrical contact with the charge (see Induction, Electric). *Indirect-arc furnaces* have an electric arc between electrodes near the charge, but *direct-arc furnaces* have an electric arc from the electrodes directly to the charge (see Electric Arc).

The temperature in an electric furnace is accurately controlled by varying the strength of the electric current. In resistor furnaces, temperatures may range between 1,000°F. and 2,800°F. The maximum temperature is determined by the melting point of the resistor material. Resistor elements made of nickel-chromium alloy produce furnace temperatures up to 2,000°F. Silicon carbide elements permit operations up to 2,800°F. The temperature of an electric arc may exceed 6,000°F. Arc furnaces may heat the charge to temperatures limited by the melting point of the furnace lining, perhaps up to 3,000°F.

Elmer C. Easton

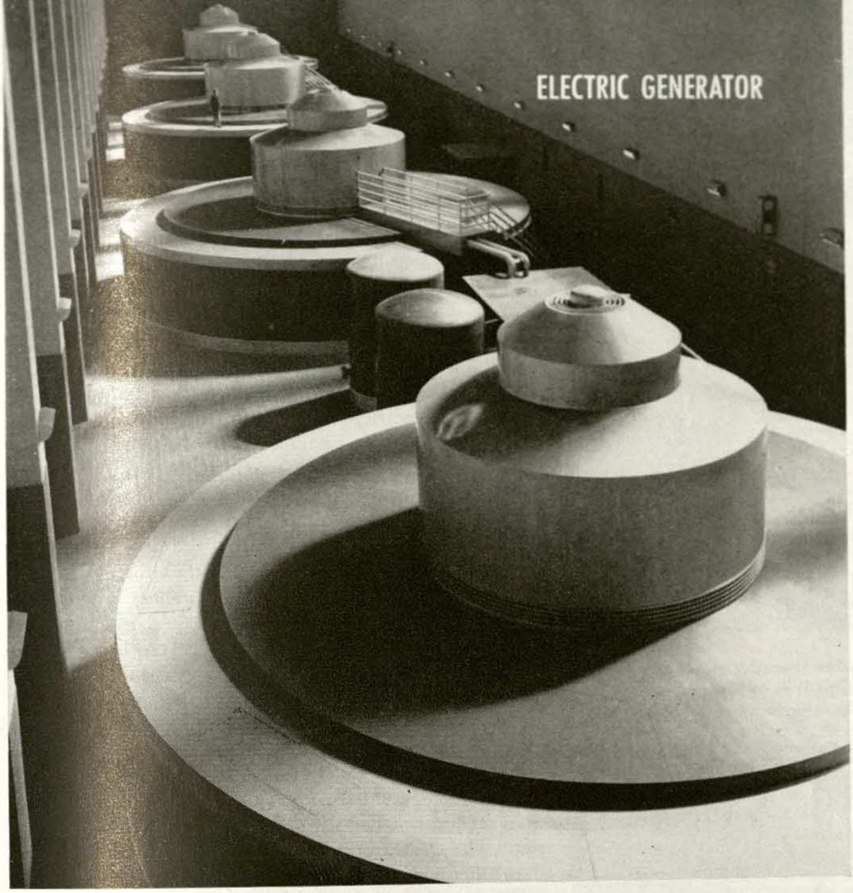
See also Furnace.

ELECTRIC FUSE. See Fuse, Electric.

Electric Furnaces melt metals at very high temperatures. This makes it possible to combine metals to make a strong, high-quality alloy. Temperatures inside the furnace may range from 2,000° F. on up. The furnace, *below*, has a steel capacity of 70 tons.

American Iron & Steel Institute

ELECTRIC GENERATOR



Four Huge Generators line the floor of a powerhouse at a TVA dam. Each generator is turned by its own water turbine and each has a capacity of 36,000 kilowatts of electricity.

ELECTRIC GENERATOR is a machine that produces electricity. Generators produce almost all the electricity used by man. They furnish the electric current that runs machines in factories, gives us lighting, and operates toasters, television sets, and other appliances in our homes.

A generator may be small enough to hold in one hand. The midget generators used in some scientific instruments produce only enough electricity to move a small pointer across a dial. Or a generator may be as large as a garage. It can supply all the electricity for a city of 500,000 persons.

The size of large generators is usually measured in *kilowatts*. One kilowatt equals 1,000 watts, the power needed to light ten 100-watt light bulbs. A giant generator can produce more than 450,000 kilowatts of electricity. See KILOWATT.

There are two main types of generators. *Direct-current (d-c) generators* produce electric current that always flows in the same direction. *Alternating-current (a-c) generators*, or *alternators*, produce electric current that reverses direction many times every second. Both kinds of generators work on the same scientific principles. But they differ in the ways they are built and used.

Electric generators were once called *dynamos*, a shortened form of the term *dynamoelectric*. But today they are known as electric generators, or simply generators.

How a Generator Works

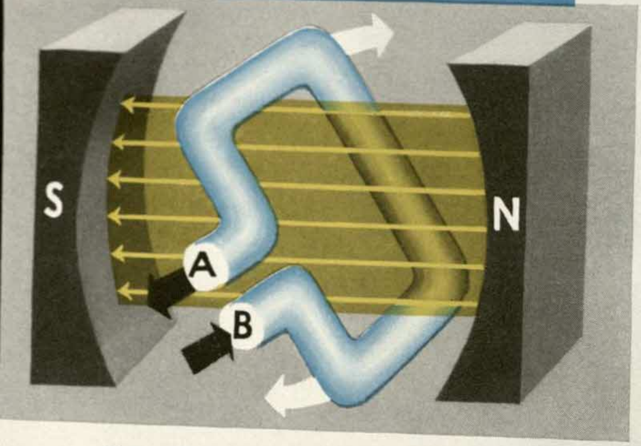
Basic Principles. A generator does not create energy. It changes mechanical energy into electrical energy. Every generator must be driven by a turbine, a diesel engine, or some other machine that produces mechanical energy. For example, the generator in an automobile is driven by the same engine that runs the car. Even windmills can drive generators.

Engineers often use the term *prime mover* for the mechanical device that drives a generator. To obtain more electrical energy from a generator, the prime mover must supply more mechanical energy. If the prime mover is a steam turbine, for example, more steam must flow through the turbine to produce more electricity. If the prime mover is a diesel engine, the engine must burn more fuel. See DIESEL ENGINE; ENERGY; TURBINE.

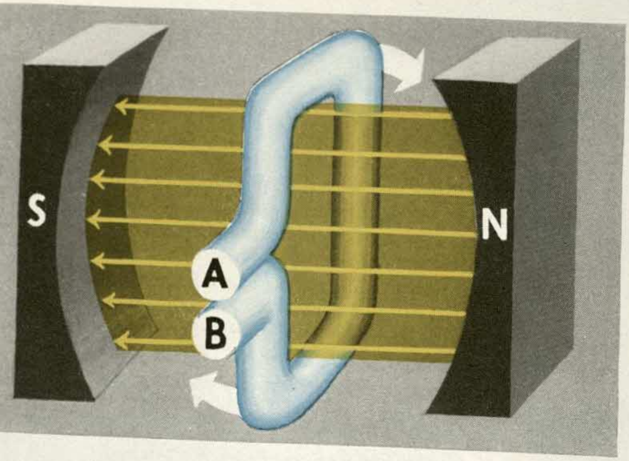
Generators produce electricity by means of a principle discovered in 1831 by Michael Faraday, an English physicist. Faraday found that he could produce electricity in a copper wire by moving the wire near a magnet or by moving a magnet near the wire. This process is called *electromagnetic induction* (see INDUCTION, ELECTRIC; MAGNET AND MAGNETISM). The *voltage*, or *electromotive force*, of the electricity produced in this way is called an *induced* voltage or *induced* electromotive force (see ELECTROMOTIVE FORCE). If the copper wire is part of a closed circuit of wires, the induced voltage causes an electric current to flow through the circuit (see ELECTRIC CURRENT).

A Simple Generator would consist of a U-shaped magnet and a single loop of wire. The area around a magnet where its force can be felt is called a *magnetic field*. To help describe a magnetic field, we think of *lines of force* going out from the north pole of a magnet and returning into the magnet at its south pole. The stronger the magnet, the greater the number of lines

HOW ELECTRICITY IS GENERATED

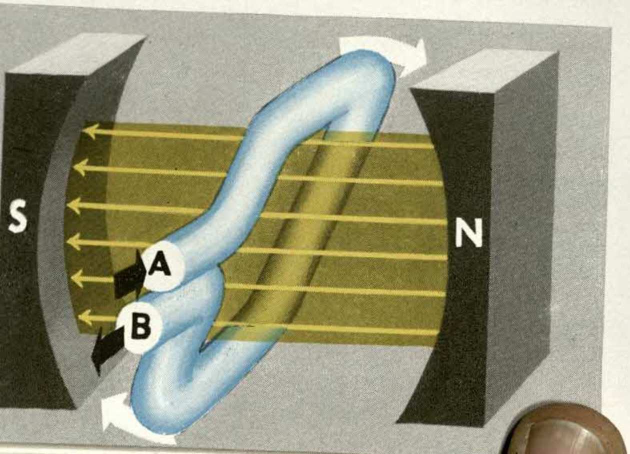


Electricity Is Generated when a conductor, such as the wire loop, *above*, cuts through the lines of force of a magnetic field. The current flows counterclockwise in the loop.



No Electricity Is Generated when the wire loop is outside the magnetic field, *above*. This is because none of the lines of force in the magnetic field are being cut.

Electricity Is Generated Again when the loop starts to cut through the lines of force. Note that the current has reversed and now flows in a clockwise direction in the loop.



of force. If you rotate the loop of wire between the poles of the magnet, the two sides of the loop "cut" the lines of force. This cutting motion *induces*, or generates, electricity in the loop.

In the first half of the turn, one side of the loop of wire cuts up through the lines of force. The other side cuts down. This makes the electricity flow in one direction through the loop. Halfway through the turn, the loop moves parallel to the lines of force. No lines of force are cut and no electricity is generated. In the second half of the turn, the side of the loop that was cutting upward cuts downward through the lines of force. The other side of the loop cuts upward. This makes the electricity induced in the loop flow in a direction opposite to the first half of the turn. At the bottom of the turn, the loop again moves parallel to the lines of force and no electricity is generated. For every complete turn, the voltage and current that are generated travel in one direction half the time, and in the opposite direction the other half of the time. Twice during each turn no current flows. The voltage and current are known as an *alternating voltage* and an *alternating current*. The voltage that a generator produces can be increased by increasing (1) the strength of the magnetic field (number of lines of force), (2) the speed at which the loop rotates, or (3) the number of loops of wire that cut the magnetic field.

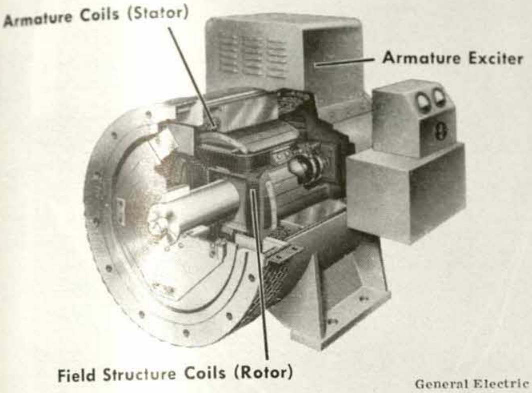
One complete revolution of the loop through the lines of force is called a *cycle*. The number of such cycles in a second is called the *frequency* of the voltage or current. The electric current used in most American homes has a frequency of 60 cycles a second.

Electromagnetism. A loop of wire rotated between the poles of a magnet produces another important electromagnetic effect in addition to generating electricity. When the loop of wire carries current, the current produces a magnetic field around the wire. This magnetic field around the wire works against the magnetic field of the magnet. It makes the loop harder to turn. The greater the amount of electricity induced in the loop, the stronger its magnetic field, and the more difficult it is to turn. That is why the prime mover that turns a generator must furnish increased amounts of mechanical energy to increase the output of current by the generator. This same magnetic force in the loop causes the rotation in electric motors. Under proper circumstances, generators can act as motors, and motors as generators. See ELECTRIC MOTOR.

Parts of a Generator. A generator has two main parts: an armature and a field structure. The *armature* contains coils of wire in which the electricity is induced. It acts like the loop of wire in the simple generator. The *field structure* acts like the simple generator's magnet. It sets up the magnetic lines of force. *Electromagnets* create the lines of force in all medium-sized and large generators, and also in many small ones (see ELECTROMAGNET). Some small generators have permanent magnets. These generators are called *magnetos* or *permanent-magnet generators*. The coils for the armature and field structure are usually insulated copper wire wound about iron cores. The iron cores strengthen the magnetic fields.

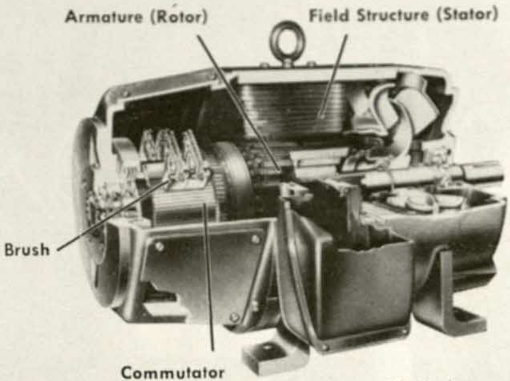
Electricity can be generated either by making the armature cut the lines of force, or by making the lines of force cut past the armature. Because of this, either the armature or the field structure can be the rotating

PARTS OF AN A-C GENERATOR



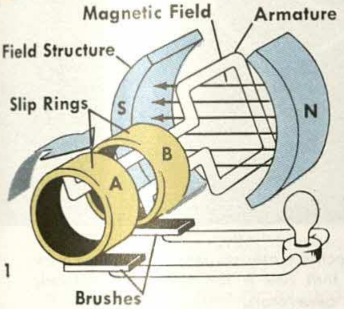
General Electric Co.

PARTS OF A D-C GENERATOR



Westinghouse

A-C GENERATOR



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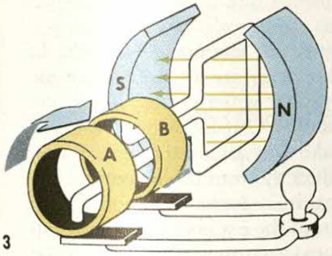


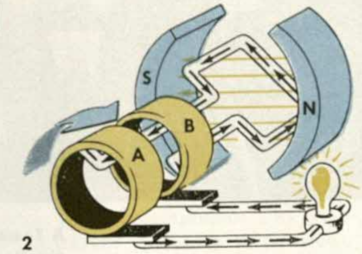
3

1. A simple alternating-current generator, *left*, has each end of its wire loop, or *armature*, attached to a *slip ring*. A carbon *brush* connected to the outside circuit rests against each of the slip rings.

2. As the armature rotates, *right*, the current moves in the direction of the arrows. The brush at slip ring A conducts the current out of the armature and the brush at ring B brings it back in.

3. When the armature rotates out of the magnetic field, *left*, no current is generated for a moment. In homes lighted by a-c current, we do not notice such stoppages, because they happen so swiftly.

4. When the armature rotates into the magnetic field again, *right*, the current reverses direction. It now flows out of the armature through slip ring B and back into the armature at slip ring A.



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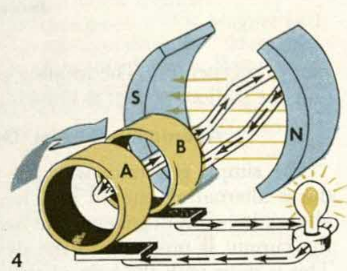

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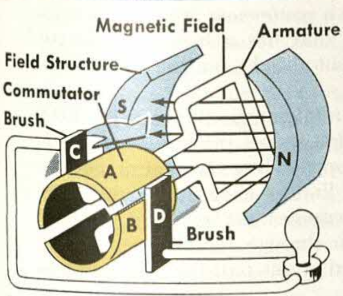
D-C GENERATOR



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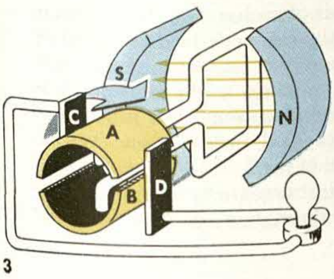


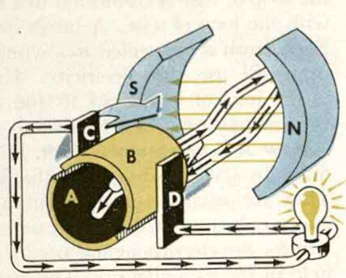
3

1. A simple direct-current generator, *left*, has each end of its wire loop, or *armature*, connected to a *commutator* segment. Carbon *brushes* connected to the outside circuit rest against each segment.

2. As the armature rotates, *right*, brush C rests against commutator segment A and conducts the current out of the armature. Brush D transfers the current back into the armature at segment B.

3. As the armature rotates out of the magnetic field, *left*, no current flows, for a moment, because none is generated.

4. In the second half of the turn, *right*, the current in the armature reverses direction and flows out of commutator segment B. But this segment now touches brush C, so the direction of the current in the outside circuit remains the same.



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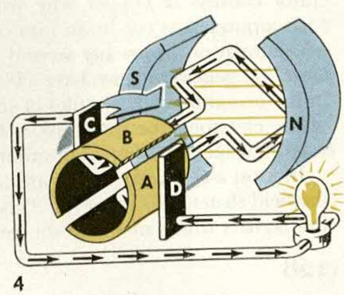

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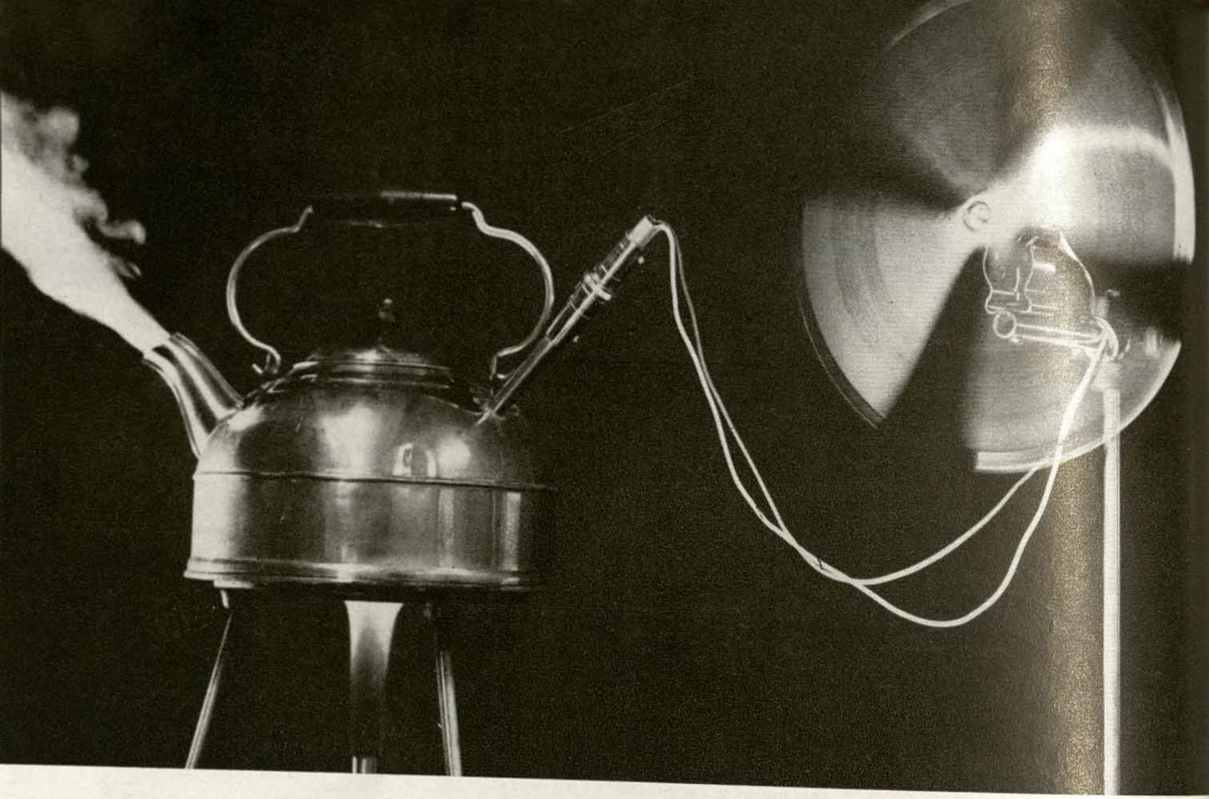


Fritz Goro, *Life*, © 1959 Time, Inc.

A Teakettle Generator has a bottom made of thermoelectric materials that can change heat directly into electricity. Heating the kettle produces current that runs a fan. Such thermoelectric devices may someday supplement or replace conventional generators.

part of a generator. The rotating part is called the *rotor* and the stationary part is known as the *stator*.

Alternating-Current Generators

The simple generator we have been describing produces alternating current in a loop of wire. To be an alternating-current generator, it needs some way to send the current it produces to the device that will use it. This is done with the help of *collector rings*, or *slip rings*, and fixed pieces of carbon called *brushes*. Each end of the loop of wire is connected to a ring. The rings rotate with the loop of wire. A brush rests against each ring. Each brush is connected to a wire leading to the device that will use the electricity. The current produced in the loop of wire flows in and out of the generator through the rings and brushes to the device.

How A-C Generators Work. Practical a-c generators differ in several ways from the simple a-c generator. They are usually equipped with a small auxiliary generator called an *exciter*. The exciter supplies direct current for the electromagnets used to create the magnetic field in the a-c generator. The armature of an a-c generator consists of copper wire wound in hundreds of coils around slots cut in an iron core. The electromagnets consist of copper bar wound around iron cores. A large a-c generator may have 30 miles of copper wire in the armature coils, 2 miles of copper bar in the coils of the electromagnets, and more than 200 miles of insulating tape hand-wrapped around the coils.

In most a-c generators, the armature is the stator and the field structure is the rotor. This means that the electromagnets which make up the field structure rotate so the magnetic field sweeps past the armature coils. In these generators, the slip rings are used to carry the direct current from the exciter generator to the electromagnets in the field structure. Outside wires connected to the armature coils take the alternating current induced in the armature directly from the armature. Engineers have found that it is easier to conduct the relatively weak current from the exciter through the slip rings and to take the heavy current produced in the armature directly from the armature. This kind of a-c generator is also called a *synchronous generator*, because it generates a voltage that has a frequency directly proportional to, or synchronized with, the speed of the rotor.

Many a-c generators rotate at speeds as high as 3,600 turns a minute. The high speeds produce heat. So do the resistance of the copper coils to the current, and the action of the magnetic lines of force in the iron cores. For this reason, the generators must be cooled. This can be done by blowing air through the generator, or by running a cooling liquid or gas past the coils and iron cores.

The field structure in an a-c generator may have only one electromagnet, but it often has two, three, four, or more. This means that the magnetic field produced by the field structure will have two, four, six, eight, or more poles—two for each electromagnet. The generator produces one complete cycle of current each time a pair of poles passes an armature coil, instead of one cycle for each complete revolution of the field structure. Depending on the number of electromagnets, these generators can produce one, two, three, four, or more cycles of current for each revolution of the field structure or of the armature.

Kinds of A-C Generators. In some a-c generators, the armature has as many sets of coils as the field structure has poles. Engineers call these generators *single-phase* generators. But most a-c generators have three sets of armature coils for each pole. These generators produce three separate currents of electricity at one time and are called *three-phase* generators. They generate more power for the amount of materials used than do single-phase generators. They also lead to better transmission and use of the power.

Uses of A-C Generators. The main generators in nearly all electric-power plants are a-c generators. This is because a simple electromagnetic device called a *transformer* makes it easy to increase or decrease the voltage of alternating current (see TRANSFORMER). Engineers build a-c generators that produce current with only a certain voltage. For many large generators, this voltage is 18,000 or 22,000 volts. By means of a *step-up* transformer, the voltage can be increased as high as 230,000 or 345,000 volts to force the current over long distances. In the area where the current is finally used, a series of *step-down* transformers lowers the voltage to a usable level. Most household appliances, for example, operate on 115 volts. Office buildings and factories use larger voltages ranging from 480 to over 4,000 volts.

Nikola Tesla, a Serbian engineer who came to the United States in 1884, developed the first successful *polyphase* a-c generators, or generators with more than one phase. He also developed electric motors to use alternating current, and transformer systems for changing the voltage of alternating current. Tesla's inventions made it economically possible to generate current far from the places where the current is used.

Direct-Current Generators

To change the simple generator into a direct-current generator, two things must be done: (1) the current must be conducted from the rotating loop of wire, and (2) the current must be made to move in only one direction. A device called a *commutator* does both tasks.

How D-C Generators Work. The commutator rotates with the loop of wire just as the slip rings do with the rotor of an a-c generator. Each half of the commutator ring is called a *commutator segment* and is insulated from the other half. Each end of the rotating loop of wire is connected to a commutator segment. Two carbon brushes connected to the outside circuit rest against the rotating commutator. One brush conducts the current out of the generator and the other brush feeds it back into the generator. The commutator is designed so that, no matter how the current in the loop alternates, the commutator segment containing the outward-going current is always against the "out" brush at the proper time. The armature in a large d-c generator has many coils of wire and commutator segments. Because of the commutator, engineers have found it simpler to have the armature serve as the rotor in d-c generators, and the field structure as the stator.

Kinds of D-C Generators. In some d-c generators, the direct current needed for the electromagnets that make up the field structure comes from an outside source, just as it does in most a-c generators. These d-c generators are called *separately excited generators.* Many other d-c generators use part of the direct current they produce to operate their own electromagnets. These generators are called *self-excited generators.* A self-excited d-c generator depends on *residual magnetism.* This means that a small amount of magnetism remains in the electromagnets after the generator is shut off. This residual magnetism must be present, or it would be impossible to start a self-excited generator once it had stopped.

The direct current needed for a self-excited generator's electromagnets can be drawn from its armature by means of three different connections. These are (1) *shunt,* (2) *series,* and (3) *compound,* a combination of shunt and series connections.

The type of generator used for a certain task depends on the amount of voltage control required. For example, a d-c generator used to charge a battery needs only simple voltage control. It might be a shunt generator. A d-c generator that supplies electricity for a passenger elevator needs more complicated voltage control. It would be a separately excited generator.

Uses of D-C Generators. Many d-c generators are driven by a-c motors in combinations called *motor-generator sets.* This is one way of changing alternating current to direct current. Factories that do electroplating and those that produce aluminum, chlorine, and some other industrial materials need large amounts of direct current and use d-c generators. So do locomotives and ships driven by diesel-electric motors. A. E. FITZGERALD

Related Articles in WORLD BOOK include:

Armature
Brush, Electrical
Dynamotor
Electric Current
Electric Motor
Electric Power
Electricity
Electromagnet
Electromagnetism
Electromotive Force
Faraday, Michael
Induction, Electric
Lenz's Law
Magnet and Magnetism
Magneto
Tesla, Nikola
Transformer
Turbine

Outline

- **I. How a Generator Works**
  - A. Basic Principles
  - B. A Simple Generator
  - C. Electromagnetism
  - D. Parts of a Generator
- **II. Alternating-Current Generators**
  - A. How A-C Generators Work
  - B. Kinds of A-C Generators
  - C. Uses of A-C Generators
- **III. Direct-Current Generators**
  - A. How D-C Generators Work
  - B. Kinds of D-C Generators
  - C. Uses of D-C Generators

Questions

About how large a city can be supplied with electricity by a large generator?

What are some of the major prime movers?

What is the *cycle* of a current? What is its *frequency?*

How does a magneto differ from most other kinds of generators?

What are the two main parts of a generator?

In what ways does a d-c generator differ from an a-c generator?

What is an *exciter?* A *rotor?* A *stator?*

Why are transformers used with a-c generators?

What are some uses of d-c generators?

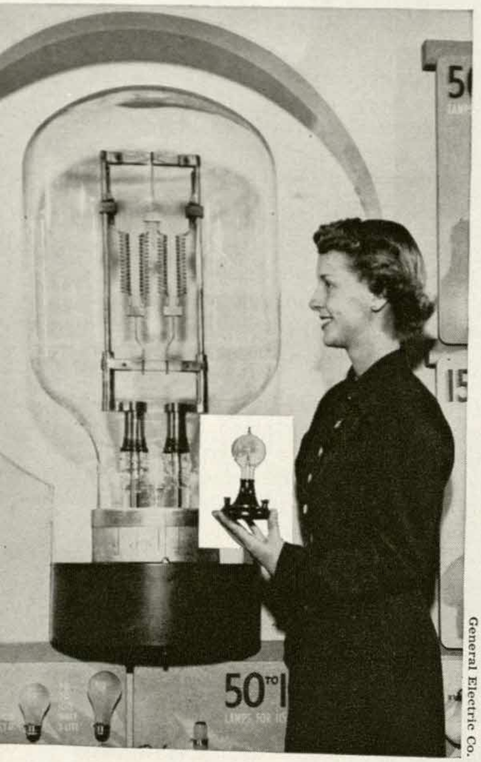
What parts did Michael Faraday and Nikola Tesla play in the development of generators?

ELECTRIC HEATING. See HEATING.

ELECTRIC HOME AND FARM AUTHORITY. See NEW DEAL (Leading New Deal Agencies).

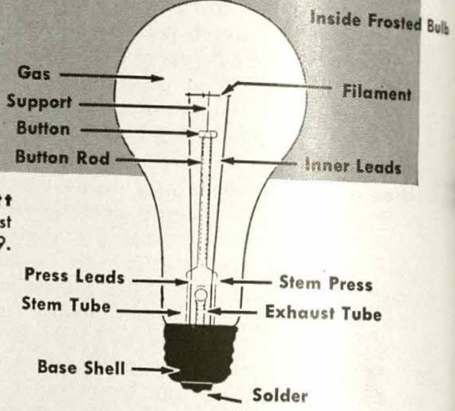
ELECTRIC INDUCTION MACHINE. See INDUCTION, ELECTRIC.

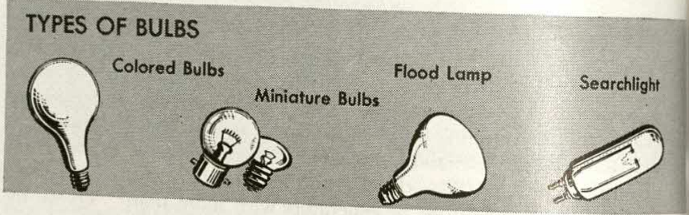
ELECTRIC LIGHT



A Giant 75,000-Watt Bulb, *left,* dwarfs Edison's first successful lamp, made in 1879.

General Electric Co.





ELECTRIC LIGHT. In the 1920's, the term *electric light* meant either the bulb used for lighting purposes in the home or the arc light used on street corners and in the theater. Today there are many kinds of electric lights, each for a specific purpose.

Electricity gives off light when it heats wire, when it passes through gases, when it gives off rays that cause other substances to give off light, and when it jumps between two pieces of carbon in the arc light.

Incandescent Light

Soon after the electric battery was developed, men found that an electric current flowing through a wire that offers great resistance to its passage will give off both heat and light, just as a piece of iron heated white hot in a furnace gives off light. The next problem was to discover what kind of wire or filament would be best for giving this kind of electric light. As early as 1859, Moses Farmer lit his house in Salem, Mass., by electric lamps that contained a glowing platinum wire. The current was supplied by batteries. These lights were not very satisfactory, however. Thomas A. Edison worked on this problem during 1878 and 1879. He wanted to find some substance that could be heated to give off light, but would not burn into an ash. To find such a substance, Edison tried thousands of materials. He tried platinum, which proved to be too expensive, and even human hair.

The Carbon Lamp. After many experiments, Edison found that carbon was the most satisfactory material for giving off light. The carbon filament through which the electricity passed had to be enclosed in a glass container from which all except one millionth part of the air had been removed. If more air is left in, the carbon combines with the oxygen in the air and burns away. Carbon is satisfactory because it has a high resistance to electricity and is easily brought to a white heat.

Edison made his first successful carbon lamp in 1879. He had tried to make the tiny thread of carbon by charring cotton thread, paper, wood, and many other substances. Bamboo proved to be the best material for his purpose. To find the best kind of bamboo, Edison sent expeditions to many parts of the world. After spending $100,000 and examining every known kind of bamboo, he decided that Japanese bamboo was the best source of carbon for lights.

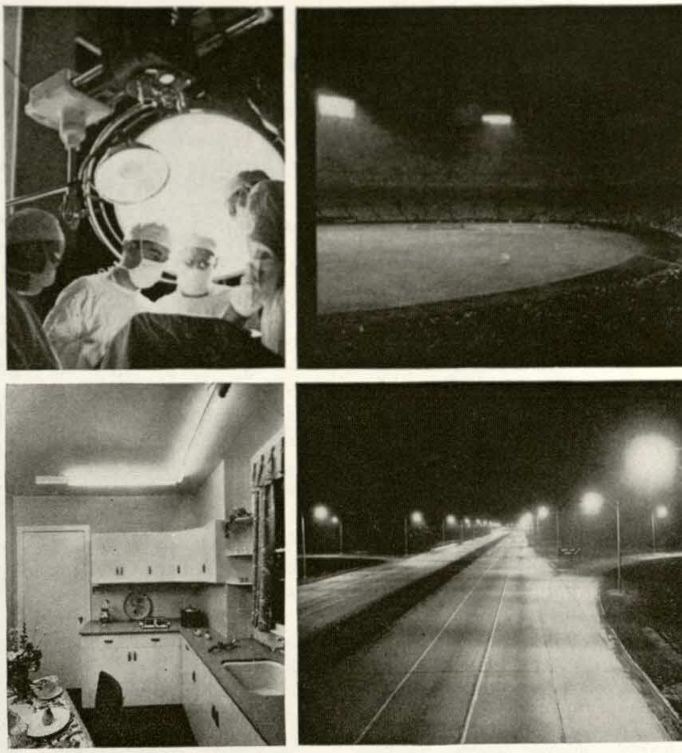
Edison next found that a new kind of carbon filament could be made by squirting a solution of cellulose through glass jets into alcohol. The alcohol hardened the cellulose, which was later carbonized through heat. The ends of the carbon filament in the light bulb were attached to platinum wires, which were sealed into the glass to make the connection with the electric current. Platinum was used because it expanded and contracted only as much as the surrounding glass did when it was heated and cooled. Therefore no air could get in.

The Tungsten Lamp. The next step in the development of the electric *incandescent* lamp came with the development of the tungsten lamp. This lamp used a tungsten wire instead of carbon. The tungsten lamp gives a whiter light than the carbon light. It also gives almost three times as much light for the electricity it uses.

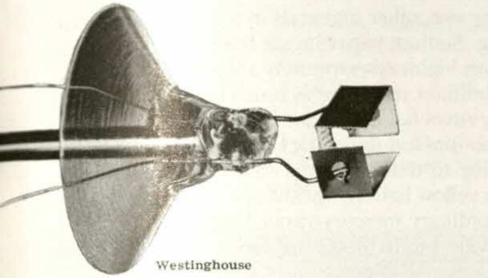
Light from an incandescent lamp is not like the light given off by sunlight. It contains more red and yellow.

Men soon discovered that the tungsten filament lasted longer and was more efficient if the light bulb contained nitrogen and argon gas, instead of being in a

Many Types of Electric Lights are best suited to specific purposes, *right*. Large tungsten-filament fixtures work well in operating rooms. Most present-day kitchens have fluorescent lights. Baseball parks usually use banks of filament flood lamps for night games. Mercury-vapor lamps line the entrances and exits to many superhighways.

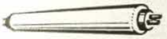


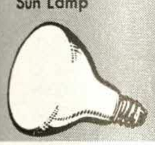
General Electric Co.; F. S. Lincoln; NBC



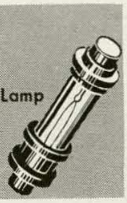
Westinghouse

The Filament Assembly of a fluorescent light starts the flow of electrons in the tube.





Sun Lamp



Water-Cooled Mercury Lamp

vacuum. The filament of tungsten in a bulb from which the air had been removed gradually evaporated and was deposited on the inside of the bulb, blackening the glass. Nitrogen and argon are inert gases and prevented the filament from evaporating. The tungsten filament was also formed into a "coiled coil." The tungsten was coiled once, and then that coil was coiled again into a second coil. This gave more filament in the same space, and therefore more light. The nitrogen-argon filled tungsten lamp is more than twice as efficient as the ordinary tungsten lamp that has its filament in a vacuum.

The light bulbs used in houses require from 60 to 150 watts to operate. Some of the largest tungsten lamps used in searchlights and in motion-picture studios need as much as 30,000 watts. Tungsten lamps come in all sizes. Some of the incandescent lights in instruments used to examine the inside of the lungs and the bladder are almost as small as a grain of wheat.

The Quartz Tubular Lamp is a new type of incandescent lamp that holds promise of wide application. It uses a new principle of manufacture called a *regenerative circuit*. In most lamps, the gases in the bulb cause the tungsten to evaporate from the filament and blacken the inside of the bulb. But, in the quartz tubular lamp, an unusual combination of gases turns the tungsten into a clear chemical, which is later redeposited on the filament as tungsten. The rest of the chemical returns to a gaseous form. The bulbs are $\frac{3}{8}$ of an inch in diameter and less than 2 inches long. They are used on the wing tips of bomber planes.

The Nernst Lamp was an interesting early experiment in making incandescent lights, although it is little used today. It was invented in 1897 by the great German physicist, Walter Nernst. It used a small rod of rare earths mixed with a binding material. The rod was heated by a small coil of platinum wire in order to make electricity pass through it. When the current was turned on, the platinum wire become red hot and heated the rod. When the rod reached the proper temperature, the electricity began to pass through it, and it glowed with an intense white light. Then the platinum coil was then turned off, because it was no longer needed.

The Mercury-Vapor Light

When the metal mercury is turned into a gas, it is an efficient conductor of electric current. It gives off a bluish-white light that contains few red rays and many ultraviolet rays. The cathode, or negative pole, of such a lamp is mercury, and the anode, or positive pole, is iron. The light is given off in a long tube from which the air has been pumped. The tube is first placed in a horizontal position until the liquid mercury in the tube extends along the entire length of the tube and completes the electric circuit. When the circuit is completed, the tube is tilted back so that the mercury drops back to one end. The electric current turns part of the mercury into a gas or vapor, and the current continues to flow through the gas. The greater the pressure inside the tube, the whiter the light that is produced. The smaller tubes that operate at high pressures become very hot. They are often made of quartz instead of glass, because quartz can withstand high temperatures without melting. Quartz also permits more of the ultraviolet rays to pass through.

Mercury-vapor lamps have many important uses. They are widely used in medicine, because their ultraviolet rays kill bacteria. The ultraviolet in mercury-vapor lamps is also important in blueprinting, photocopying, bleaching, and chlorination. For general lighting purposes, mercury-vapor lamps are used wherever it is not necessary to distinguish between colors, as in steel plants, airplane factories, foundries, and on highways and city streets.

Fluorescent Light

Fluorescent light also uses the conduction of electricity through mercury vapor. The fluorescent light is much more efficient than the tungsten light, which turns only 6 to 8 per cent of the energy used into actual light. The fluorescent light turns 13 to 15 per cent of the energy into light. In the fluorescent light the mercury vapor is not used to give off light directly. Instead, the vapor gives off rays that are used to cause fluorescence, or glowing, in other substances. The inside of the fluorescent light tube is coated with materials called *phosphors*. They glow with a visible light when they are struck by invisible ultraviolet rays. When these substances are properly blended they can offer a white light or a light that combines different colors. Zinc silicate coated on the inside of the tube gives off green light; calcium tungstate gives off blue light; and magnesium tungstate gives off a yellowish-white light.

Each fluorescent light requires a heating unit for starting. These heaters give off electrons that turn the mercury vapor in the tube into ions and make it conduct electricity more readily. A reactor coil chokes off currents which might become dangerously large. Often the starting voltages are greater than the ordinary 110 to 120 volts of house currents. Some of these lighting fixtures need a transformer to step up the current.

In a new type of fluorescent lighting, a series of grooves alternates from one side to the other inside the bulb, and keeps the arc from going in a straight path from one end of the bulb to the other. The grooves force the arc to proceed in a wavy line, and therefore travel a longer distance. For example, an arc inside an 8-foot bulb can be made to travel 9 feet. The added distance traveled by the arc increases the amount of light that the 8-foot tube can give off.

Instead of bulbs or tubes, flat panels of glass may be used to light the walls or ceiling of a room. This method of producing light is called *electroluminescence*. The phosphor material is placed between two conductors, across which the voltage is applied. The lamp remains cool, and usually produces a green light. Scientists are working to develop new colors. The use of electroluminescent lighting is limited to places of relative darkness, because even the brightest electroluminescent lamps are dimmer than the smallest ordinary lamps. At present, electroluminescent lighting is used in night lights, on clock faces, and on the instrument panels of airplanes. In one type of electroluminescent lighting, phosphor is applied to steel mesh, plastic, or nylon, so that these materials will light a room when they are used in drapes, window shades, or other similar fabrics and materials.

Neon Lights

Neon lights, like mercury and fluorescent lights, are made possible by the fact that electricity can be conducted through a gas and made to give off light. Some small neon lamps operate at ordinary house voltage. Others which are made up as long tubes for advertising displays require electricity of higher voltage. The color of the light given off by a conducting gas depends upon the kind of gas used. Neon gives off a red light in tubes; argon gives off blue. The tubes can also be colored to affect the color of the light.

In some cases, other materials in a gas form are used for lighting. Sodium-vapor lamps have been used with success along highways, especially at intersections. They give off a brilliant yellow light, much brighter than that of ordinary street lights, and are inexpensive to operate. Some authorities feel that their brilliant light also serves as a warning to traffic. A later form of mercury lamp produces a yellow light by means of a phosphor coating inside an ordinary mercury-vapor bulb. Krypton-filled lamps provide bright flashes of light to mark airport runways.

KARL A. STALEY

Related Articles in WORLD BOOK include:

Arc Light
Edison, Thomas A.
Electric Current
Electric Eye
Electric Meter
Electric Sign
Electric Switch
Electronics
Flashbulb
Flashlight
Fluorescent Lamp
Lighting
Neon
Searchlight
Tungsten
Vapor Lamp

ELECTRIC LOCOMOTIVE. See ELECTRIC RAILROAD; LOCOMOTIVE.

ELECTRIC MEASUREMENT. Electricity is not an object which can be weighed or marked off in feet or inches, but it can be measured by its effects. Electric current can be measured by the heat it induces in a conductor, by its chemical effect, and by the power of its magnetism. Just as feet, inches, or miles represent distances that man decided they should represent, there are a number of units that man has decided upon for measuring electrical quantities.

The strength of an electric current is measured in *amperes*. By law, the ampere is defined in terms of the amount of force it produces, expressed in newtons. A *newton* is an absolute unit of force.

Electromotive force, the force which drives an electric current around a circuit, is measured in *volts*. The current which is driven through a circuit by an applied electromotive force is limited by the resistance of the circuit. The resistance is measured in *ohms*. One volt will drive a current of one ampere through a resistance of one ohm. The current equals the applied voltage divided by the resistance of the circuit in ohms.

A *coulomb* is the amount of electric charge transmitted by one ampere in one second. The coulomb was made the legal unit of electricity in the United States by Act of Congress on June 12, 1894.

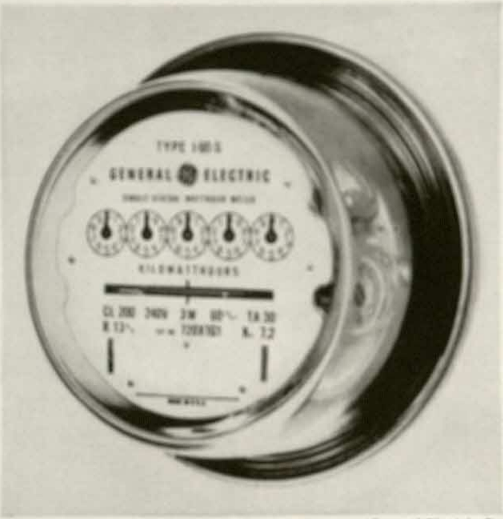
A *farad* is the capacitance of a capacitor which is charged by one coulomb of electricity so that it has a potential difference of one volt (see CAPACITANCE). A *watt* is a unit of electric power. One volt times one ampere equals one watt. A *kilowatt* is equal to 1,000 watts and is the same as 1.34 horsepower. One *horsepower* equals .746 kilowatt.

E. R. WHITEHEAD

Related Articles in WORLD BOOK include:

Ammeter
Ampere
Coulomb
Electric Meter
Farad
Galvanometer
Kilowatt
Ohm
Volt
Voltmeter
Watt
Wattmeter
Wheatstone Bridge

ELECTRIC METER

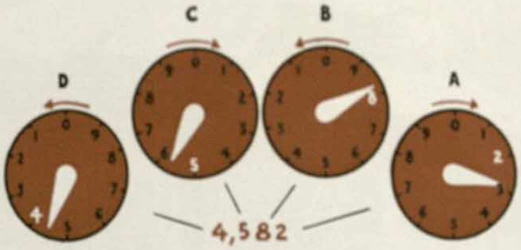


Watt-Hour Meters, *right,* are tightly sealed inside glass cases that keep out dust and moisture.

General Electric Co.

A Meter Reader reads electric meters periodically. The customer's bill is based on these readings.

Commonwealth Edison



Electric-Meter Dials read, *from right to left,* in units of ones, tens, hundreds, and thousands. Some meters have a fifth dial that registers in units of 10,000, like the meter in the photograph, *top.* Dial A's pointer must make a complete revolution for dial B's to move ahead one unit, and so on down the line.

ELECTRIC METER is a device that measures electric current. Electric utility companies use *watt-hour meters* to measure in kilowatt-hours the amount of electrical energy used by their customers. A kilowatt-hour is 1,000 watt-hours. Ten 100-watt light bulbs turned on for one hour will use 1 kilowatt-hour of electricity (see Kilowatt). The utility company connects the meters to the lines supplying electricity to a home or factory. The meter is read at regular intervals and the customer's bill is based on these readings.

A watt-hour meter operates on the principle of electromagnetism (see Electromagnetism). It has a thin metal disk mounted so that it rotates in the field of an electromagnet. The electromagnet is connected to the line supplying electricity to the customer. The greater the *load,* or amount of electricity used by the customer, the stronger the electromagnetic field becomes. The stronger this field, the faster the disk turns. A system of gears registers the disk's rotations on four dials in kilowatt-hour units. A permanent magnet keeps the disk from turning when no electricity is being used.

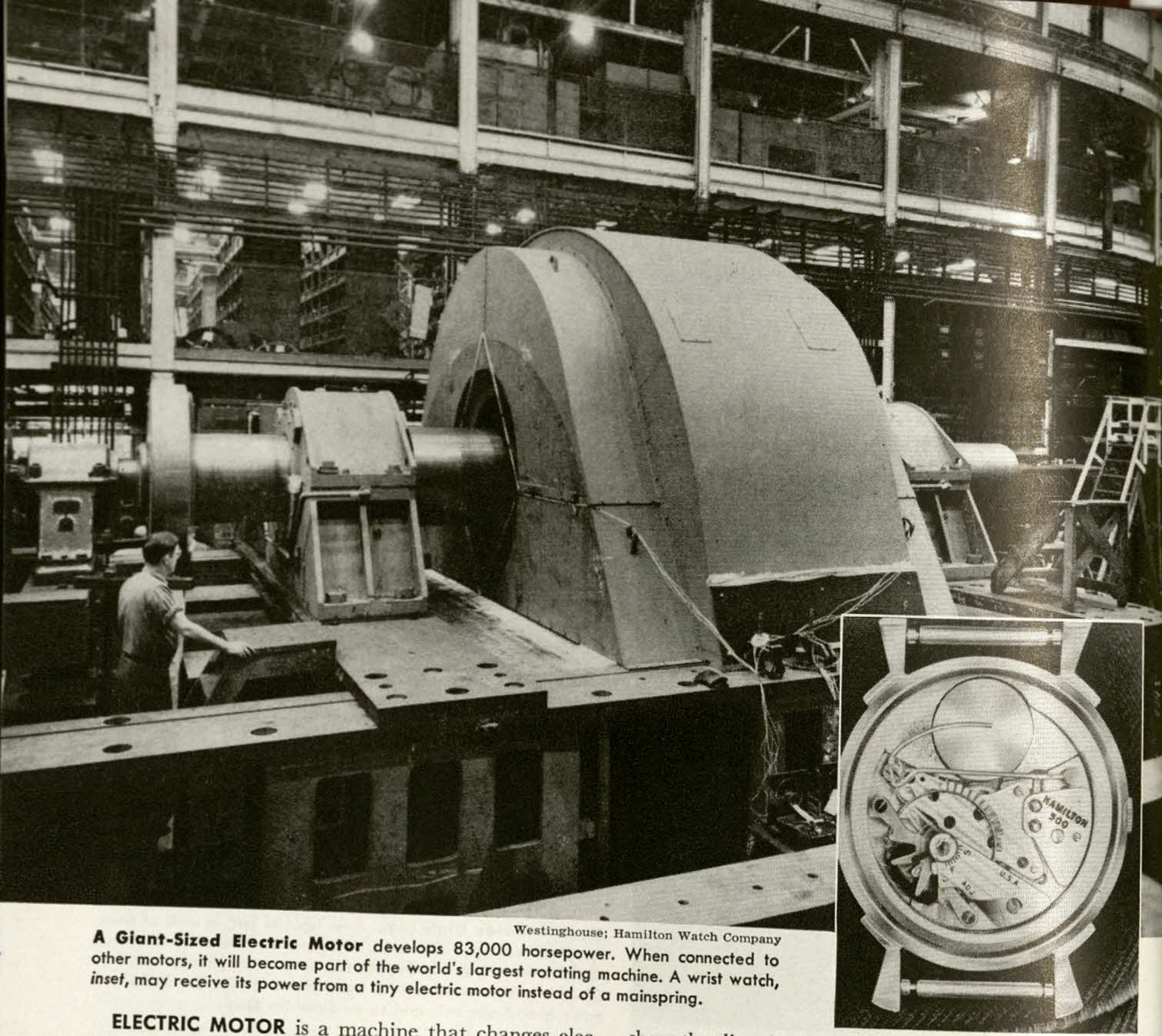
Each of the four dials has a pointer and is divided into units of ten, numbered from 0 to 9. The right dial registers kilowatt-hours in units of 1 up to 10. The next dial to the left indicates kilowatt-hours in units of 10 up to 100. The third dial records kilowatt-hours in hundreds up to 1,000, and the fourth dial registers kilowatt-hours in thousands up to 10,000. The entire meter is sealed inside a glass case which keeps out dust and moisture.

Utility companies usually use a watt-hour meter that also has a *demand indicator* to measure the power used by industrial and large commercial customers. This indicator has a pointer that shows on a graduated scale the highest number of kilowatts required by the customer in a given period. The pointer is usually reset to zero after the meter is read. Some demand meters record the varying kilowatt requirements of the customer on a chart.

Many persons contributed to the development of the electric meter. But Oliver B. Shallenberger made the first really successful meter in 1888. In 1895, he patented a design for an induction watt-hour meter regarded as the basis of all watt-hour meters used today.

Other kinds of electric meters include galvanometers and ammeters to detect and measure the strength of a current (see Ammeter; Galvanometer). Voltmeters and wattmeters measure the voltage or power of a current (see Voltmeter; Watt). Commonwealth Edison Company

See also Weston, Edward.



Westinghouse; Hamilton Watch Company

A Giant-Sized Electric Motor develops 83,000 horsepower. When connected to other motors, it will become part of the world's largest rotating machine. A wrist watch, *inset*, may receive its power from a tiny electric motor instead of a mainspring.

ELECTRIC MOTOR is a machine that changes electric energy into mechanical power to perform work.

The electric motor is used for almost every purpose that requires electric power to run machinery. Electric motors range in size from the tiny devices that operate sewing machines to the great engines in heavy locomotives. In almost all modern factories, each machine is run by its own motor. Even a machine that generates its own electricity must be driven by a motor.

Basic Principles

The electric motor is based on three principles. (1) When an electric current passes through a conductor, it induces magnetism around the conductor. If the conductor is wound in the form of a coil it becomes an effective bar magnet. The coil is then called an *electromagnet* because its magnetism is caused by electricity. (2) Like poles on magnets repel each other, and unlike poles attract each other. (3) The direction of the current determines the polarity of an electromagnet. A simple rule of thumb, called the *right-hand rule*, shows the relation between the direction of the current and the magnetic poles. Hold a coil of wire in your right hand with the fingers pointing with the current. Your thumb then points toward the *N* pole of the coil. If you know the *N* pole of a coil, you can use the reverse of this rule to show the direction in which the current is flowing.

Send a current through a coil of wire and suspend the coil between the ends of a U magnet. The coil will rotate until its *N* pole is opposite the *S* pole of the magnet. The coil's *S* pole will be opposite the *N* pole of the magnet. This is the basic principle on which the electric motor works.

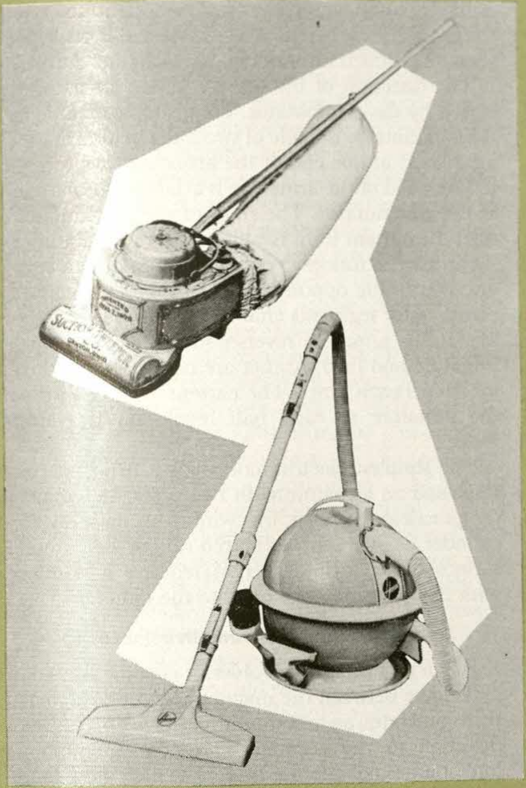
Parts of the Electric Motor

The parts of a direct-current motor are (1) a stationary magnet, known as the *field magnet;* (2) a coil called an *armature*, that is free to rotate between the poles of the stationary magnet; (3) a device called a *commutator* that changes the direction of the current in the armature. The armature is mounted on a drive shaft that can be used to transmit power to other machines.

How an Electric Motor Works

A current is passed through the armature, making it an electromagnet. The armature turns until its poles are next to the opposite poles of the magnet. The armature would stop turning if the direction of the current on the armature were not reversed. The timing is such that the current reverses just as the *N* pole of the armature is next to the *S* pole of the magnet. The *N* pole of the armature becomes an *S* pole and is repelled by the *S* pole

USES OF ELECTRIC MOTORS

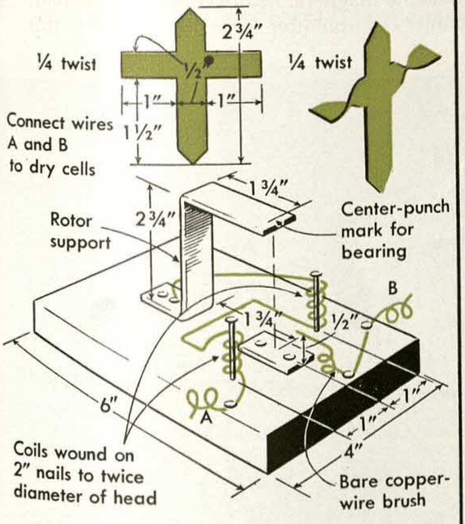


The Hoover Co.; Courtesy Delco Products

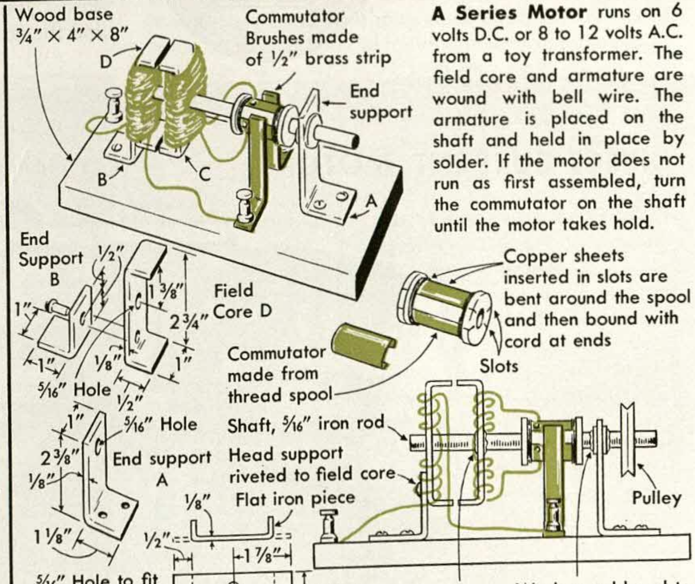
Electric Motors in Vacuum Cleaners make housekeeping easier. Motors in early models, *top*, took up more room and were noisier than the motors used in modern cleaners.

ELECTRIC MOTORS ARE USED THROUGHOUT A HOME

HOW TO MAKE YOUR OWN ELECTRIC MOTOR


¼ twist
2¾″
½″
1″
1″
1½″
Connect wires A and B to dry cells
¼ twist
Rotor support
2¾″
1¾″
Center-punch mark for bearing
B
1¾″
½″
6″
A
1″
1″
4″
Coils wound on 2″ nails to twice diameter of head
Bare copper-wire brush

A Tin-and-Nail Electric Motor can be made with simple materials. In this device, the cross-shaped rotor turns between two coils after being given a slight push. The brush is set to rub lightly against the edges of the rotor.


Wood base ¾″ × 4″ × 8″
D
Commutator Brushes made of ½″ brass strip
End support
B
C
A
End Support B
½″
1″
1⅜″
2¾″
Field Core D
1″
⅛″
1″
5⁄16″ Hole
½″
1″
5⁄16″ Hole
2⅜″
⅛″
End support A
1⅛″
Commutator made from thread spool
Copper sheets inserted in slots are bent around the spool and then bound with cord at ends
Slots
Shaft, 5⁄16″ iron rod
Head support riveted to field core
Flat iron piece
⅛″
½″
1⅞″
5⁄16″ Hole to fit shaft
1″
Armature core C
Bend
Pulley
Armature core soldered to shaft
Washers soldered to shaft for thrust

A Series Motor runs on 6 volts D.C. or 8 to 12 volts A.C. from a toy transformer. The field core and armature are wound with bell wire. The armature is placed on the shaft and held in place by solder. If the motor does not run as first assembled, turn the commutator on the shaft until the motor takes hold.

Courtesy, *Popular Mechanics*

of the magnet. The armature makes another half turn until its two poles are again next to opposite poles on the magnet. Then the current reverses again, and the armature turns again. The armature continues to turn in the same direction as long as the current is on. When the armature turns, it turns the shaft which runs the machine.

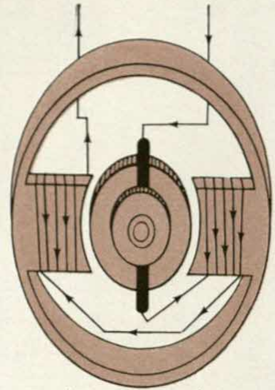
The direction of the current in the armature is reversed by the commutator. For a simple electric motor, the commutator is made of two half-circular rings. They are placed at one end of the armature and rotate with it. Each end of the armature is attached to one segment of the commutator. The rings of the commutator conduct the current from the circuit to the armature when the armature rotates. When the poles of the armature are next to the opposite poles of the field magnet, the commutator segments change brushes. Hence, the current in the armature reverses so that now like poles of armature and field magnet are next to each other, and they repel each other. The current reverses direction in the armature at each half revolution the armature makes.

The simplest electric motor has a two-part commutator and an armature with two poles. In motors used for practical purposes the wire is wound on an iron cylinder, the wires being placed side by side around the surface of the cylinder. This requires a commutator with many segments to operate the motor.

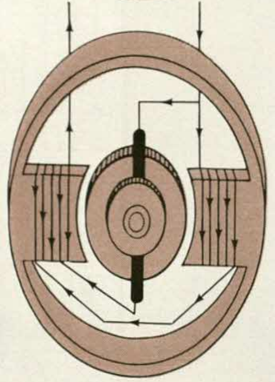
Counter-Electromotive Force

When an armature revolves, it cuts the lines of magnetic force between the magnets. Cutting the magnetic field generates an electromotive force in the opposite direction to the current. This counter-electromotive force pushes against the driving voltage and limits the speed of the motor. The more often the armature cuts the field of force, the more the counter-electromotive force is generated. When a motor is pulling a light load, the counter-electromotive force is almost equal to the applied voltage because the generator turns over very rapidly and cuts the field many times per second. When the load is increased, the armature turns over more slowly. It cuts the magnetic field less often per second, and the counter-electromotive force decreases. For this

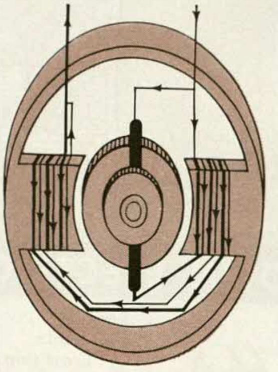
TYPES OF ELECTRIC MOTORS



The Series-Wound Motor sends the current through the armature and the magnet in a *series,* or one after the other. The current increases the armature current and the magnetism. The motor can be adjusted to run at variable speeds.

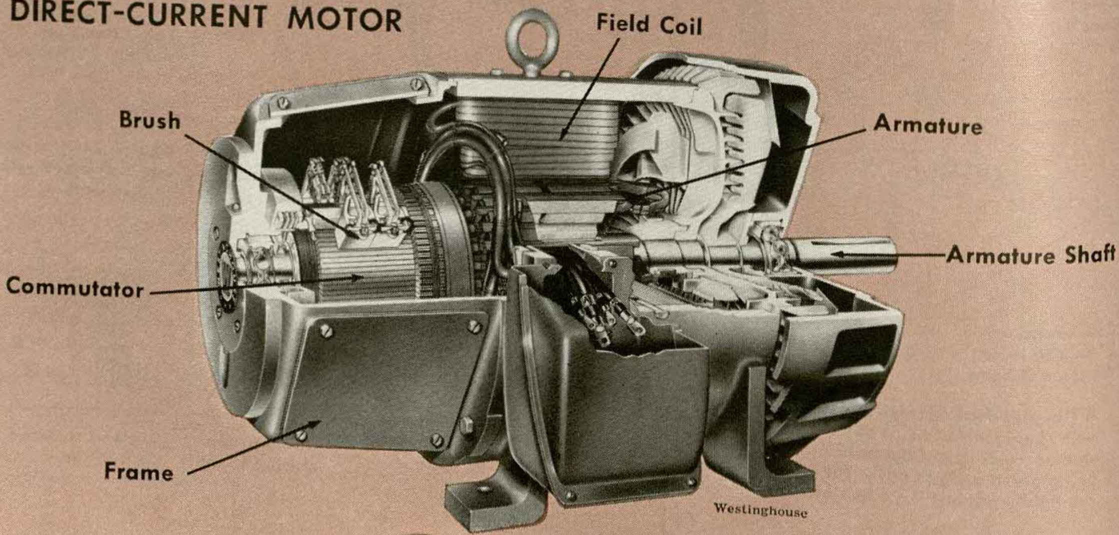


The Shunt-Wound Motor sends part of the current through the armature, and part through the magnet. The magnetic field depends on the resistance of the wire around the magnet, and not on the motor load. This lets the motor run at a constant speed.



The Compound-Wound Motor resembles both a series motor and a shunt motor. Part of the current goes around the magnet. The other part goes around the magnet and the armature. Such motors are used where great increases in power are needed.

DIRECT-CURRENT MOTOR



Westinghouse

reason, an electric motor is more efficient when it is operating to carry a heavy load than a light load.

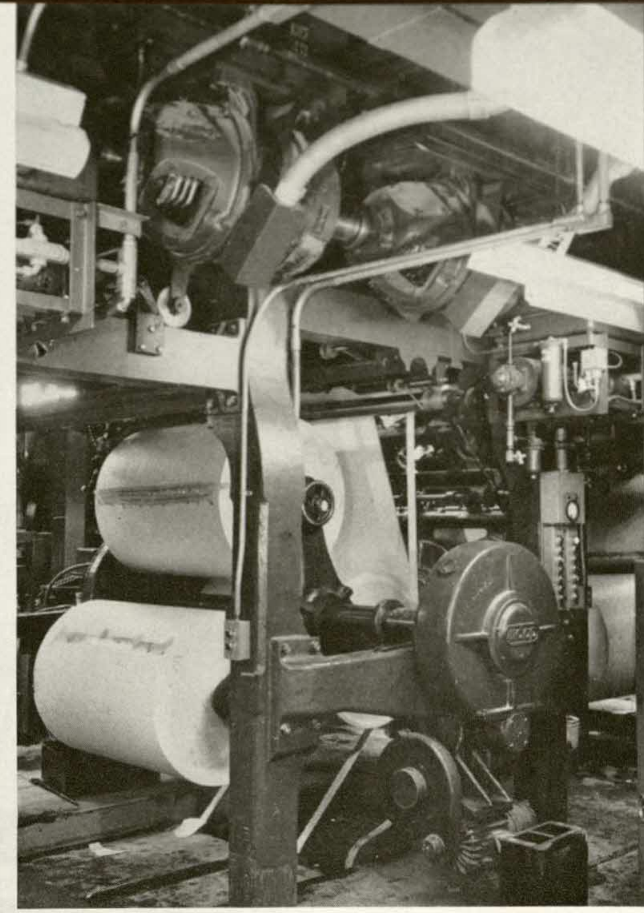
Kinds of Electric Motors

There are several types of electric motors in use today. These include the series motor, the shunt motor, the compound motor, and the induction motor.

The Series Motor is the most widely used electric motor and is also the simplest. The current passes through both the armature and the field magnet in a series, that is, one after the other. The current increases the strength of the magnets. When the current is increased the armature current is increased, and the magnetism is increased. The magnet's strength increases greatly. For light loads, the torque, or turning force, of the motor is proportional to the square of the strength of the current that is moving through the motor at the time. If two amperes will move a load of four pounds, four amperes will carry a load of 16 pounds. On heavy loads the magnets reach the limit of their magnetic strength, called *saturation*. The armature current is increased when the current is increased. The torque increase of the motor is nearly in proportion to the current increase when the field magnets are saturated.

The Shunt Motor divides the current so that one part goes through the magnet and the other part goes through the armature. One wire is wound around the magnet many times because the magnetism is increased each time the current flows around the magnet. But the length of the wire increases its resistance to the current. The current that flows around the magnet and produces the magnetizing effect depends only on the resistance of the wire and not on the load on the motor. For this reason, an increased load has little effect on the magnetic field. No matter what the load is, the shunt motor runs with almost the same speed. In the operation of a machine, it is used where a fairly uniform speed is required. The series motor is used where great torque is needed to start the motor.

The Compound Motor is a combination of the series and the shunt motors. One branch of the current goes around the magnet, as in the shunt motor. The other branch has a low resistance. It goes around both the magnet and the armature, as in the series motor. The current flows in the same direction in the two branches and greatly increases the magnetism. The load can be increased suddenly without great effect on the speed of the motor. Compound motors are used in rolling mills and other places where the load may be increased very suddenly.



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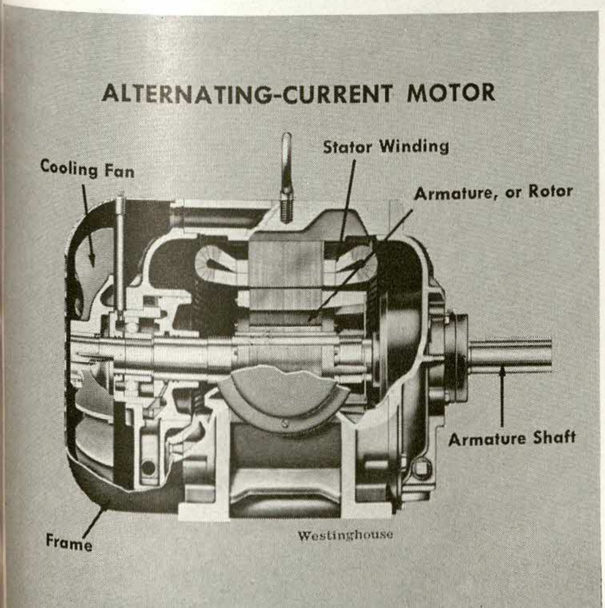
Electric Motors Keep Giant Newspaper Presses Going. Presses actually have several electric motors, each motor performing a definite task. Motors feed the rolls of paper to the presses, turn out the printed pages, fold the papers, and bind them together in small packages for distribution.

ALTERNATING-CURRENT MOTOR



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The Induction Motor has no electrical connection to the armature. Therefore, it needs no commutator or brushes. It uses an alternating current. The armature is an iron core with slots around its outer edge. In the slots are placed copper bars fastened to copper rings at the ends. An alternating current produces a rotating magnetic field in the field magnet, thus inducing a magnetic field in the armature. This induced field rotates with magnetism of the rotating field and causes the armature to rotate. The induction motor is easy to build and is widely used in household appliances, such as electric clocks.

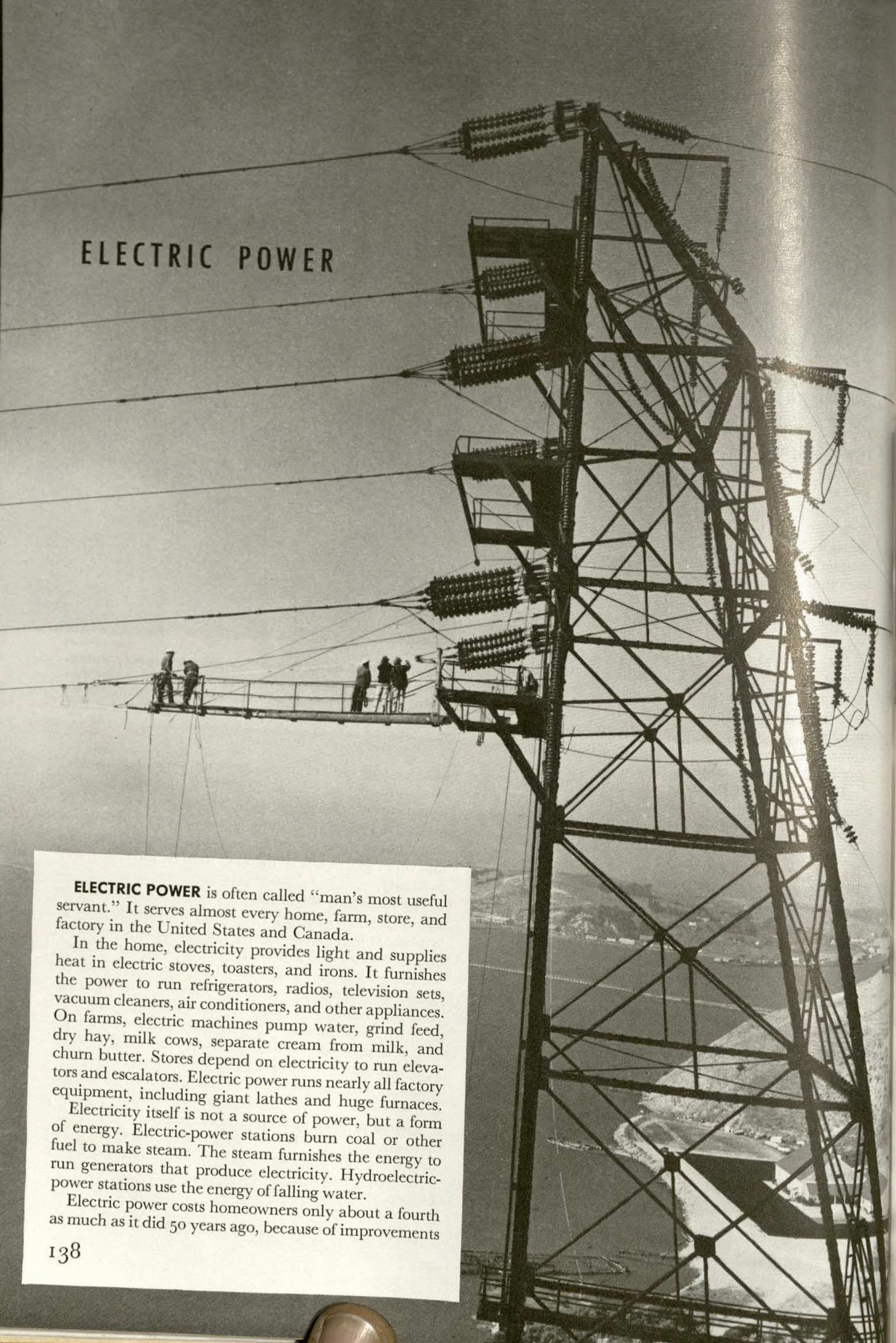
Clifford Holley and Elmer C. Easton

Related Articles in World Book include:

Armature
Brush, Electrical
Dynamotor
Efficiency
Electric Current
Electric Fan
Electric Generator
Electricity
Electromagnet
Electromotive Force
Magnet and Magnetism

ELECTRIC, or **ELECTRONIC, ORGAN.** See Organ.

ELECTRIC POWER



ELECTRIC POWER is often called "man's most useful servant." It serves almost every home, farm, store, and factory in the United States and Canada.

In the home, electricity provides light and supplies heat in electric stoves, toasters, and irons. It furnishes the power to run refrigerators, radios, television sets, vacuum cleaners, air conditioners, and other appliances. On farms, electric machines pump water, grind feed, dry hay, milk cows, separate cream from milk, and churn butter. Stores depend on electricity to run elevators and escalators. Electric power runs nearly all factory equipment, including giant lathes and huge furnaces.

Electricity itself is not a source of power, but a form of energy. Electric-power stations burn coal or other fuel to make steam. The steam furnishes the energy to run generators that produce electricity. Hydroelectric-power stations use the energy of falling water.

Electric power costs homeowners only about a fourth as much as it did 50 years ago, because of improvements

Hydroelectric Projects, such as Hoover Dam, *right,* generate about a third of the world's electric power.

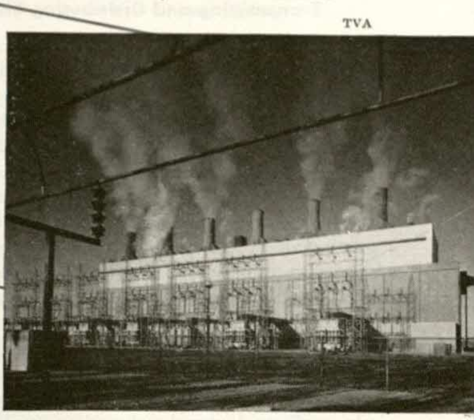
High-Voltage Lines supported by huge steel towers transmit electric power from distant generating plants to cities where it will be used.

Pacific Gas and Electric Co.

Bureau of Reclamation

Steam-Turbine Plants produce more than two thirds of the world's electric power. This plant is in Tennessee.

TVA



Commonwealth Edison Co.

Atomic-Power Plants, like the one in Illinois, *left,* use nuclear reactors to supply the energy to generate electricity.

made in generating and distributing electricity. The United States produces 50 times as much electric power as it did 50 years ago.

Producing Electric Power

Large generators in power stations produce almost all our electric power. A typical power-plant generator may have a capacity of 100,000 kilowatts. This is enough electricity to light a million 100-watt light bulbs at any given time. The amount of electric power that a power plant actually produces is measured in kilowatt-hours. See ELECTRIC GENERATOR; KILOWATT.

Turbines drive almost all electric generators in power plants. The two chief kinds of turbines are steam and water turbines. In addition, some power plants also use gas turbines. See TURBINE.

Steam-Turbine Plants produce almost four fifths of the electric power in the United States, and more than two thirds of the world's electric power. Steam-turbine plants in the United States have a total capacity of more than 100,000,000 kilowatts of electricity.

Water-Turbine, or *Hydroelectric, Plants* produce slightly more than a fifth of the electric power in the United States, and a little less than a third of the world's electric power. In the United States, hydroelectric plants have a capacity of more than 29,700,000 kilowatts of electricity.

Gas Turbines can be started more easily and quickly than steam turbines. For this reason, some power plants install gas-turbine generators to supply extra electric power during periods when the demand for power rises, such as on a dark, cloudy day when more than the normal number of lights may be turned on. Gas turbines are not used to produce the normal output of a power station, because they cost more to operate than steam turbines.

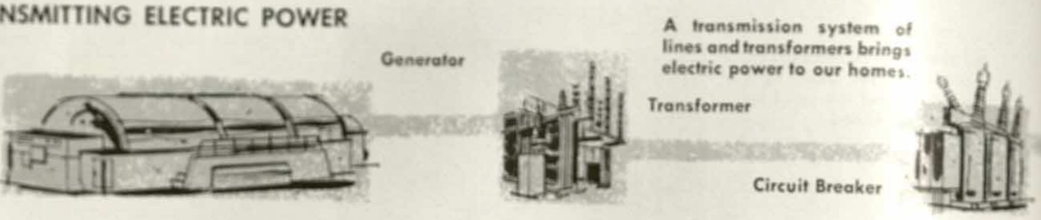
Atomic Energy. Atomic-power plants generate electricity in exactly the same way as steam-turbine electric-power plants. The only difference is that an atomic-power plant uses a *nuclear reactor* as a furnace to heat water into steam, instead of using a coal- or oil-burning furnace. See ATOMIC ENERGY (In Producing Power; Atomic Energy Throughout the World).

The big advantage of an atomic-power plant lies in the amount of fuel used. One tablespoon of uranium provides as much energy as 750 tons of coal! An atomic-power plant can operate many months without refueling.

The United States Atomic Energy Commission's Testing Station at Arco, Ida., generated the first electricity with atomic power in 1951. By the late 1950's, there were three additional atomic-power plants in the United States, and others in Great Britain and Russia.

Other Methods. *Diesel engines* are widely used to drive generators, mostly in city power stations. Diesel-driven generators in the United States have a total capacity of more than 2,500,000 kilowatts. *Gasoline engines* may also be used to drive small generators. Factories sometimes use these generator units to supply electricity for

TRANSMITTING ELECTRIC POWER



A transmission system of lines and transformers brings electric power to our homes.

special equipment such as welding machines. *Windmills* have been used to drive generators that supply electric power in small quantities. Underground heat from geysers and volcanoes has also been used.

Transmitting and Distributing Electric Power

Generating electricity is only part of the process of supplying electric power. The electricity must be transmitted from the power plant to the city or area that uses it. Then the electricity must be distributed to homes, farms, factories, and other individual users.

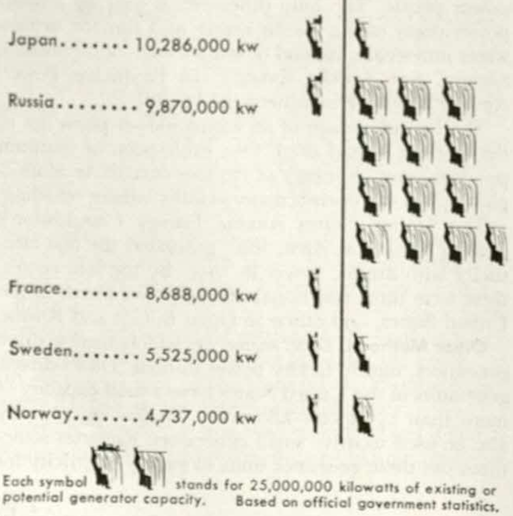
Transmission Over Long Distances. A generator in a power plant may produce electric current with a voltage as high as about 22,000 volts. But still higher voltages are needed to send the current over long distances. High voltages make it possible to cut losses of power that occur during transmission. These losses result from the resistance of the transmission line to the flow of the current and other factors (see ELECTRIC CURRENT). Large transformers in the power plant increase the voltage to as much as 345,000 volts (see TRANSFORMER). In 1958, engineers developed an experimental 750,000-volt transmission line near Pittsfield, Mass.

Most electric-power companies operate a number of generating stations at various locations throughout a particular region. The transmission lines of one station are usually connected in a network with the lines of the company's other stations. In this way, if one station receives an unexpected demand for additional electric power, it can call on the other stations to help meet the demand. The network enables a company to route power along different lines if one transmission line is damaged or shut down for repairs.

The transmission systems of many electric-power companies are also linked to each other. This provides *pools*, or reserves, of electric power. Each system usually has spare generators that can supply extra electric power as needed. In this way, no area will be without electric power if one company has a power failure.

Distribution to Local Users. Transmission-line voltages are too high for local users. When electric power reaches the area where it will be used, transformers lower the voltage to 34,000 volts, or some other suitable voltage. Some big industrial plants receive electric power at 13,800 volts or higher. This is also the voltage used to send the electric power to *distribution substations*, where the voltage is lowered again to between 2,000 and 13,800 volts. Some industries need current at these

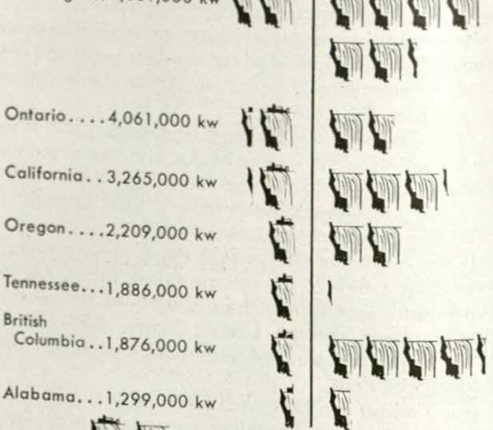
EIGHT LEADING HYDROELECTRIC POWER COUNTRIES



Country	Developed Capacity
United States	29,761,000 kw
Canada	12,497,000 kw
Italy	11,103,000 kw
Japan	10,286,000 kw
Russia	9,870,000 kw
France	8,688,000 kw
Sweden	5,525,000 kw
Norway	4,737,000 kw

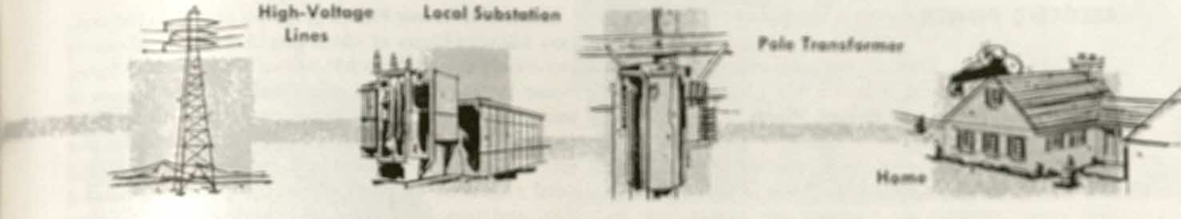
Each symbol stands for 25,000,000 kilowatts of existing or potential generator capacity. Based on official government statistics.

EIGHT LEADING HYDROELECTRIC POWER STATES AND PROVINCES



State or Province	Developed Capacity
Quebec	6,335,000 kw
Washington	4,661,000 kw
Ontario	4,061,000 kw
California	3,265,000 kw
Oregon	2,209,000 kw
Tennessee	1,886,000 kw
British Columbia	1,876,000 kw
Alabama	1,299,000 kw

Each symbol stands for 3,000,000 kilowatts of existing or potential generator capacity. Based on official government statistics.



voltages and receive it directly from the distribution substation. But homes, stores, and farms need current at still lower voltages, usually from 120 to 240 volts. This voltage is obtained through small transformers fastened to the poles that support the electric-power wires running to homes, stores, and other individual users of electricity.

Operating a Power System. Electricity must be generated at the time it is needed. The operator, or *load dispatcher*, of a power system knows from experience how much power will be needed from one hour to the next. For example, he knows that sudden, dark storm clouds will cause a greater demand for power, because many lights will be turned on.

In a typical dispatching station, the system operator has a map of the company's power system. This map shows all the generating stations, transmission lines, distribution substations, and connections with neighboring power systems. Colored lights show which transmission lines are being used. The operator knows how much power is being sent over the transmission lines, and how much more electric power his system can produce with spare generators or by running the main generators at full output. He can use this spare power as needed. If he sees that he needs still more extra power, he can ask the operator of a neighboring system for additional power. More and more power stations are using automatic load-dispatching equipment.

Electric Power in the United States

More than three fourths of the electricity produced for public use in the United States is generated and distributed by privately owned electric-power companies. Power plants operated by cooperatives and by the federal, state, and city governments produce and distribute the remainder. This does not include the electricity generated by industry for its own use.

Privately Owned Power Plants. The United States has more than 1,900 privately owned power plants. The largest of these plants is the Clifty Creek Plant of the Indiana and Kentucky Electric Company at Madison, Ind. It has generating equipment with a capacity of 1,284,000 kilowatts.

Thomas A. Edison built the first steam electric-power plant in the United States. This plant, the Pearl Street Station, went into operation in New York City on Sept. 4, 1882. It supplied power to light 400 of Edison's newly invented incandescent lamps in 59 buildings.

Annual Electric-Power Production in the United States

States	*Kilowatt-Hours
Alabama	24,731,000,000
Alaska	308,000,000
Arizona	8,616,000,000
Arkansas	6,987,000,000
California	51,774,000,000
Colorado	4,876,000,000
Connecticut	7,425,000,000
Delaware	2,160,000,000
District of Columbia	1,375,000,000
Florida	15,730,000,000
Georgia	11,406,000,000
Hawaii	1,380,000,000
Idaho	5,166,000,000
Illinois	41,445,000,000
Indiana	31,128,000,000
Iowa	7,194,000,000
Kansas	7,068,000,000
Kentucky	19,073,000,000
Louisiana	15,841,000,000
Maine	4,152,000,000
Maryland	7,769,000,000
Massachusetts	12,125,000,000
Michigan	28,851,000,000
Minnesota	9,189,000,000
Mississippi	3,130,000,000
Missouri	8,387,000,000
Montana	4,595,000,000
Nebraska	3,691,000,000
Nevada	3,019,000,000
New Hampshire	2,682,000,000
New Jersey	16,676,000,000
New Mexico	2,965,000,000
New York	46,197,000,000
North Carolina	19,787,000,000
North Dakota	1,973,000,000
Ohio	49,257,000,000
Oklahoma	7,230,000,000
Oregon	13,918,000,000
Pennsylvania	43,374,000,000
Rhode Island	1,901,000,000
South Carolina	9,778,000,000
South Dakota	1,715,000,000
Tennessee	34,284,000,000
Texas	44,777,000,000
Utah	3,935,000,000
Vermont	1,036,000,000
Virginia	16,355,000,000
Washington	28,922,000,000
West Virginia	16,450,000,000
Wisconsin	13,560,000,000
Wyoming	1,073,000,000

*Source: *Statistical Abstract of the United States*

Annual Electric-Power Production in the Canadian Provinces and Territories

Provinces and Territories	*Kilowatt-Hours
Alberta	3,097,466,000
British Columbia	12,373,217,000
Manitoba	3,643,243,000
New Brunswick	1,813,235,000
Newfoundland	1,448,638,000
Nova Scotia	1,650,042,000
Ontario	33,378,151,000
Prince Edward Island	71,142,000
Quebec	44,853,926,000
Saskatchewan	2,099,678,000
Yukon and Northwest Territories	184,826,000

*Source: Dominion Bureau of Statistics, Canada

That same year, a small hydroelectric plant began operating in Appleton, Wis.

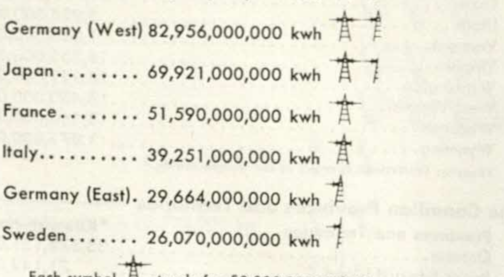
Government-Owned Power Plants. The United States government operates about a hundred electric-power projects. These projects produce about 17 per cent of the country's electricity. Most of the larger federal power projects are hydroelectric plants built in connection with dams. These projects include the dams and power plants of the Tennessee Valley Authority and Grand Coulee and Bonneville dams on the Columbia River. See DAM; TENNESSEE VALLEY AUTHORITY.

The largest federal hydroelectric plant is the Grand Coulee station, with a capacity of 1,962,000 kilowatts. The Tennessee Valley Authority has the largest steam-turbine power plant in the United States. This plant, at Kingston, Tenn., has a capacity of 1,600,000 kilowatts. In 1958, construction began on a 500,000-kilowatt steam-turbine generator for the TVA at Widow's Creek, Ala. This is believed to be the world's largest steam-turbine generator.

The Atomic Energy Commission is the chief user to receive electricity directly from federal projects. Other users include the aluminum and chemical industries. Almost half of the federal electric-power output is distributed through the power systems of private companies, city governments, and cooperatives.

The power plants of city governments, state projects, power districts, and cooperatives produce about 7 per cent of the electricity in the United States. These four groups distribute electric power to about a fifth of the users of electricity in the country. *Power districts* consist of several counties that join together to produce and distribute electric power. *Cooperatives* are nonprofit power systems, usually established to provide electricity in rural areas not served by other suppliers. See COOPERATIVE; RURAL ELECTRIFICATION ADMINISTRATION.

TEN LEADING ELECTRIC POWER COUNTRIES



United States	643,541,000,000 kwh
Russia	180,350,000,000 kwh
Great Britain	96,781,000,000 kwh
Canada	83,210,000,000 kwh
Germany (West)	82,956,000,000 kwh
Japan	69,921,000,000 kwh
France	51,590,000,000 kwh
Italy	39,251,000,000 kwh
Germany (East)	29,664,000,000 kwh
Sweden	26,070,000,000 kwh

Each symbol stands for 50,000,000,000 kilowatt-hours of electrical energy produced each year.

Based on a 4-year average of government statistics.

Industrial Power Plants generate about 80,000,000,000 kilowatt-hours of electricity a year, or about 12 per cent of the total electric power in the United States. Some factories and industries need large amounts of steam or heat for processing operations. This steam or heat is obtained after it has first been used to produce electricity. Some chemical and metallurgical industries need enormous amounts of electric power 24 hours a day, and may have their own hydroelectric developments. Other industries have fuels, such as refinery exhaust gases, that can be used to generate electricity.

Electric Power in Other Countries

Russia produces about a tenth of the world's electric power and ranks second to the United States, which produces two fifths of the world's electricity. The two leaders are followed by Great Britain and Canada.

Norway stands first in the amount of electric power produced per person. It has an abundance of water power and generated more than 6,750 kilowatt-hours a year per person in the late 1950's. Canada was second, with a production of over 5,500 kilowatt-hours annually per person. The United States was third, with slightly over 4,000 kilowatt-hours per person a year.

Outside the United States, steam-turbine power plants produce about three fifths of the world's electric power, and hydroelectric plants about two fifths. The largest electric-power projects outside the United States include the 600,000-kilowatt Dnepr River plant in Russia; the 600,000-kilowatt Supung plant of North Korea on the Yalu River; the 500,000-kilowatt Cubatao project at Cubatao, Brazil; and the 345,000-kilowatt Aswân Dam project in Egypt. In 1958, Russia began construction of a 2,000,000-kilowatt power plant at Kuybyshev and a 1,750,000-kilowatt project at Stalingrad, both on the Volga River.

CLARENCE H. LINDER

Related Articles in WORLD BOOK include:

Atomic Energy
Dam
Electric Current
Electric Generator
Electricity
Federal Power Commission
Turbine
Water Power

Outline

I. Producing Electric Power
- A. Turbines
- B. Atomic Energy
- C. Other Methods

II. Transmitting and Distributing Electric Power
- A. Transmission Over Long Distances
- B. Distribution to Local Users
- C. Operating a Power System

III. Electric Power in the United States
- A. Privately Owned Power Plants
- B. Government-Owned Power Plants
- C. Industrial Power Plants

IV. Electric Power in Other Countries

Questions

What are some of the uses of electric power on farms?

How is the production of electric power measured?

About how much of the electricity in the United States is supplied by steam-turbine plants?

What kind of turbine might be used to supply extra electric power?

What is the big advantage of atomic-power plants?

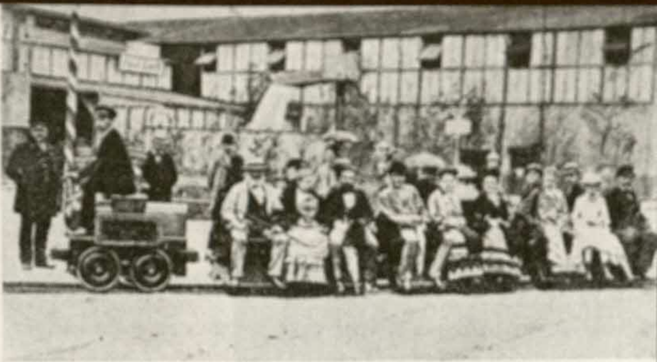
In what ways are transformers used in transmitting and distributing electric power?

What do storm clouds mean to a load dispatcher?

Who built the first U.S. steam electric-power plant?

Where was the first hydroelectric plant built?

What country leads in electric power per person?



Electric Railroad Assn.

The World's First Commercial Electric Railroad, above, was shown at the Berlin Exhibition of 1879. The engine pulled three cars that carried 20 passengers at a speed of 8 miles an hour. It took its power from a generator by means of a third rail.

Modern Electric Trains provide efficient service for both passengers and freight.

General Electric Co.

ELECTRIC RAILROAD is an electric-powered railway system. In addition to some railroads, subway and elevated systems in large cities are familiar types of electric railways. Their power is usually generated in a power plant and passed along the railroad to separate traction motors used to drive the car wheels.

Several ways can be used to get the current from the central powerhouse to the cars. Some railroads have overhead lines above the track. A metal bar, or trolley pole, reaches up from the car or locomotive, slides along the overhead line, and collects and transmits power to the locomotive or car. The bar is held against the wire by an accordionlike metal frame, or *pantograph*, which can be raised or lowered and which carries the conductors. The current travels through the conductors down to the motors near the wheels, and drives the motors. The engineer operates a device called a *controller* in the cab of the locomotive or car. It regulates the amount of power going into the traction motors, and in this way regulates the speed.

In Washington, D.C., which does not permit overhead wires, the electric street railway uses the *conduit system*. Two *conductor bars* sunk in slots between the tracks carry the current. Cars receive the current through metal shoes that press against the bars.

Other electric trains get their power from a *third rail* placed beside the track. The motors receive electricity from metal shoes that slide along this rail.

Electric Locomotives. Many large locomotives now run on electric power. They have one or more traction motors geared to the driving axles. Electric locomotives range in weight from 110 to more than 364 tons. The largest can produce over 9,000 horsepower. A typical electric locomotive in use in the United States weighs about 230 tons, has 4,620 horsepower, and a top speed of 100 miles an hour.

Diesel locomotives use diesel engines for their power. The engine drives generators that produce electricity. The generators drive electric motors geared to the wheels.

History of Electric Railroads. By the mid-1800's, inventors were trying to use electric power to run cars and trains. Thomas Davenport, a blacksmith of Brandon, Vt., built a model electric railway in 1835. Three years later, Robert Davidson invented an electric locomotive which ran on the Edinburgh-Glasgow Railway.

The cost of producing electricity was too great for general use by railroads until the electric generator was invented (see ELECTRIC GENERATOR). This device generated a current of high voltage at low cost and made the modern electric railway possible. The first locomotive that took its power from a generator by means of a third rail was shown at an exposition in Berlin, Germany, in 1879. Thomas A. Edison invented an electric locomotive that ran on a special track at Menlo Park, N.J., in 1880.

The first commercial electric street railway began operation in Lichterfelde, Germany, in 1881. Frank J. Sprague, who had worked with Edison, demonstrated the first practical electric motor for use in locomotives in 1884. Sprague inaugurated a small electric railway at St. Joseph, Mo., in 1887, and, later that year, built the Union Passenger Railway in Richmond, Va. This was the first large electric railway system ever attempted. The first main-line electrification was on the Baltimore and Ohio tunnel district at Baltimore, Md., in 1895. Electric elevated trains began operation in Chicago, Boston, Brooklyn, and New York City within the next few years.

CHARLES O. MORGRET

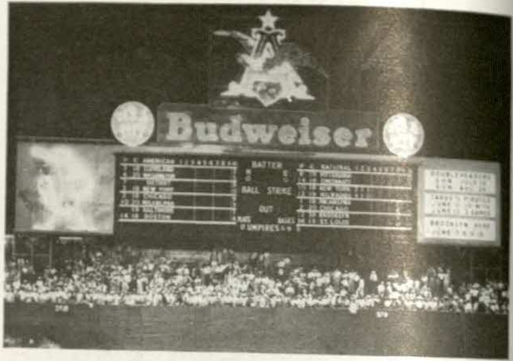
Related Articles in WORLD BOOK include:

Diesel Engine
Electric Current
Elevated Railroad
Locomotive
Maine (Interesting Places to Visit)
Railroad
Streetcar
Subway

ELECTRIC RAY. See TORPEDO (fish).

ELECTRIC SHOCK. See SAFETY (Safe Use of Electricity); SHOCK TREATMENT.

ELECTRIC SIGN

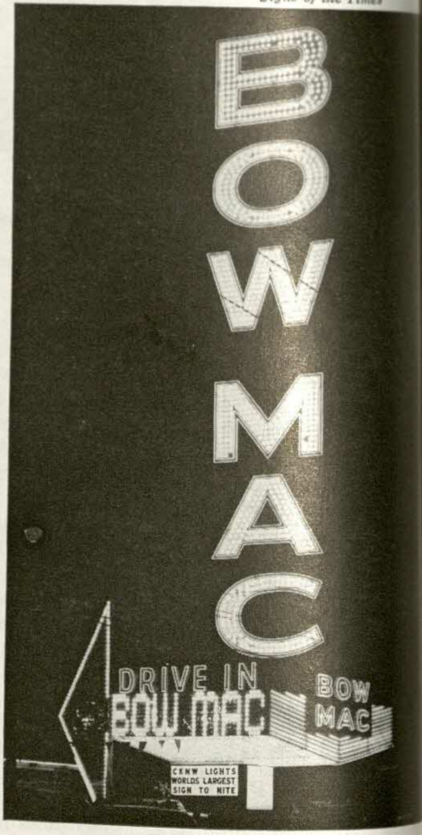


Signs of the Times

A Spectacular Electric Sign in Busch Stadium, home of the St. Louis Cardinals, gives the scores of all major-league baseball games.

General Outdoor Advertising Co.

Flashing Neon Signs help light up Chicago's Michigan Avenue, *left.* Many signs are arranged so that different designs appear at intervals.



Signs of the Times

The Towering Electrical Display, *right,* is about 100 feet high. It contains 4,149 feet of neon tubing and 3,376 white frosted incandescent lamps.

ELECTRIC SIGN is a sign that is lighted by electric lights, or neon, argon, or helium gas so it shows at night. When electric signs were first used, the design of the advertisement was cut in a sheet of wood or metal, and the lights were placed behind to make the design stand out in the dark. Today the design is traced by the light bulbs themselves, or by neon tubes. Much of the excitement and color of New York City's Broadway is caused by the hundreds of electric signs which have given the street the name "Great White Way."

In many electric signs the circuit is arranged so that some of the lights are off while others are on, and the sign flashes first one design and then another. Some signs display movement. Dancers kick legs, boxers jab at each other, bubbles float up the sign, and messages seem to float across the sign one word after another. Automatic switching of the current causes all these various movements. The same type of movements can be represented by neon signs. The first neon advertising sign was installed in 1923 on the Cosmopolitan Theatre in New York City. Some electric signs have large cut-out figures, such as an automobile or a person, that stick out from the main signboard.

The development of fast-starting fluorescent lamps has made fluorescent electric signs practical and popular. One type uses *transilluminated* elements, or translucent plastic or glass. Fluorescent bulbs inside the sign make the message visible from both sides.

The most important qualities of an electric sign are brightness, clarity, and smoothness. The sign must be bright so it can be seen from a distance. The sign must be clear so it can be read at a glance. The bulbs must be placed just the right distance apart so their fields of light will not blur. The sign must be evenly lighted so that every letter and every part of the design stands out as clearly as the rest. Competition between signs has led to ever brighter lights. The use of electric signs for advertising has become so widespread that many buildings are erected with supports and fixtures to which lights can be attached. Illusions of movement in such signs are produced by motor-driven electric contacts or switches arranged on drums. Signs of this kind are called *flashers*.

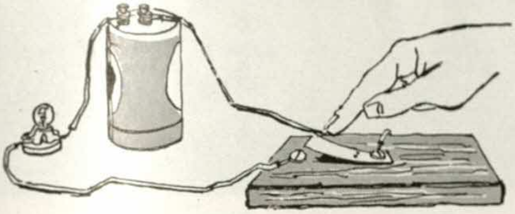
Raymond F. Yates

See also Electric Light; Neon.

ELECTRIC SWITCH

Minneapolis-Honeywell

An Electric Switch breaks or completes an electric circuit. Pushing the household light switch, *above,* joins contacts so that current flows or separates contacts to cut off the current. Pressing down the metal strip on the homemade knife switch, *below,* completes the circuit to light the bulb.



ELECTRIC SWITCH is a device that breaks or connects an electric circuit. The light switch used in homes is a common example of an electric switch. It has wire contacts in the wall. The current flows in one contact and out the other. Buttons in the wall connect to the contacts. When one button is pushed down, the contacts join so that the current flows, and the lights go on. When the other button is pushed, the contacts separate, the current is cut off, and the lights go out. Snap switches move in one direction for "off" and in the opposite direction for "on."

Another common type of switch is the *knife switch.* Its contacts are in metal slots. A blade like a knife blade is pulled in and out of the slots to complete the circuit. A *double* knife switch has two blades connected together by an insulating handle so that they can be moved, or "thrown," together.

A *circuit breaker* is a type of switch which cuts the current automatically when the current is too strong. *Oil switches* have contacts which move in oil to prevent sparking. *Air break switches* make and break contact in air. *Mercury switches* operate silently. Low voltage remote control switches are safe and economical, and have a variety of uses. RAYMOND F. YATES and ELMER C. EASTON

See also CIRCUIT BREAKER; ELECTRIC CURRENT.

ELECTRIC TRANSFORMER. See TRANSFORMER.

ELECTRIC WELDING. See WELDING.

ELECTRIC WIRING is the system of wires and cables that distributes electricity throughout a home, store, factory, or other building. One of the most important tasks of such wiring is to supply electricity for lighting. It may also have to supply electricity to operate air conditioners, electric stoves, and many other appliances. A wiring system should be designed to meet all the expected demands for electric power at the least amount of cost.

Planning and installing electric wiring involves many factors. One of the most important is the safety factor. Short circuits resulting from inadequate and improperly installed wiring are a common cause of fires. The National Electrical Code, first established in 1897, sets minimum standards for acceptable wiring. It includes rules for the installation and construction of electrical appliances to eliminate fire hazards. This code is revised every two years. Other factors include the various wiring methods and kinds of wire that may be used, and planning how to route the wires through a building. Much of this work has been standardized by designs and laws.

The details of a wiring system depend largely on the amount of electric power that will be needed. For example, this would dictate whether a two-wire or a three-wire system would be used. Most home wiring systems provide a number of circuits. Each circuit is usually limited to 15-ampere, 117-volt current. Such circuits usually have plug-type fuses (see FUSE). The number of circuits depends on the total power needs. Large appliances such as electric stoves and clothes dryers require three-wire, 234-volt circuits. Many kinds of wires, insulation, switches, and outlets have been developed to meet varying voltage and current requirements. SAMUEL SEELY

ELECTRICAL ATTRACTION. See ATTRACTION.

ELECTRICAL ENERGY. See BATTERY.

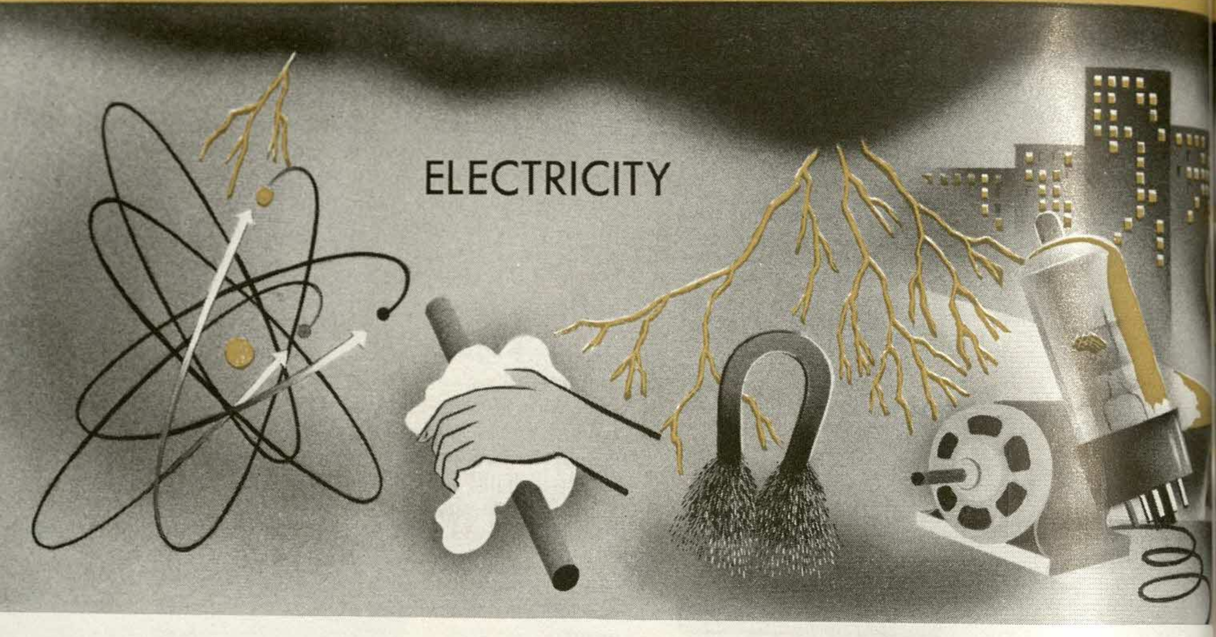
ELECTRICAL ENGINEER. See ENGINEERING (Kinds of Engineering; Careers in Engineering).

ELECTRICAL, RADIO AND MACHINE WORKERS, INTERNATIONAL UNION OF, is a labor union which belongs to the American Federation of Labor and Congress of Industrial Organizations. It is the world's largest union of electrical-manufacturing workers. It was chartered in 1949, after the CIO expelled the United Electrical, Radio and Machine Workers of America on the grounds that it was a communist organization. The union has headquarters at 1126 16th St. N.W., Washington, D.C. For membership, see LABOR (table). LES FINNEGAN

ELECTRICAL WORKERS, INTERNATIONAL BROTHERHOOD OF, is a labor union affiliated with the American Federation of Labor and the Congress of Industrial Organizations. It was organized in 1891 as the National Brotherhood of Electrical Workers. In 1899, it opened membership to Canadians and took its present name. Headquarters are at 1200 15th St., Washington 5, D.C. For membership, see LABOR (table). INTERNATIONAL BROTHERHOOD OF ELECTRICAL WORKERS

ELECTRICIAN is a person who repairs, installs, operates, or maintains electrical devices. He must know the principles of electricity as well as have a knowledge of its many practical applications. He must understand electric circuits, wiring, insulation, batteries, motors, generators, transformers, and electron tubes. An electrician must also know how to read an architect's drawing so that he can install electrical equipment in new buildings. His knowledge of electric lighting makes it possible for him to install the different types of electric lighting, such as fluorescent and incandescent lamps. Electricians usually begin their trade by serving an apprenticeship under an experienced electrician. See also BUILDING TRADE (Career Opportunities); ENGINEERING (Electrical Engineering).

ELECTRICITY



ELECTRICITY, *ee lek TRIS uh tih,* is a form of energy. We know what it is by what it does. Electricity gives us light, heat, and power. It brings us radio, television, motion pictures, and the telephone.

Electricity comes into our homes and schoolrooms on wires. The electric current follows a wire *circuit*, usually made of copper or aluminum wires. Electric current is easily turned on or off by switches. When a switch is open, it leaves a gap in the circuit and electricity cannot flow past.

Electricity produces heat. In an electric light bulb, a thin wire becomes white-hot when electricity flows through it. In an electric heater, a thicker wire grows red-hot when electricity flows through it.

Electricity can exert a force. To make an electric bell ring, an electric magnet pulls a piece of iron against the bell. To make an electric motor work, the magnetic force of electricity turns it. When you listen to a telephone or a radio, the magnetic force of electricity makes the sound you hear. By another kind of electric force, called *electrostatic* energy, a comb will pick up bits of paper, and a piece of nylon cloth will cling to your hand.

Scientists know that the electricity that flows through the wires in your home is made up of tiny particles called *electrons*. These particles are much too small to be seen, even with a microscope. Electrons are the smallest particles of electricity, just as atoms are the smallest particles of matter. Atoms have a relationship to electrons, because every atom contains one or more electrons. A hydrogen atom has one electron, a helium atom has two, and so on. Everything is partly electrical.

This article tells the basic principles of electricity. For descriptions of how electricity is produced and transmitted commercially, see the articles on ELECTRIC GENERATOR and ELECTRIC POWER.

Uses of Electricity

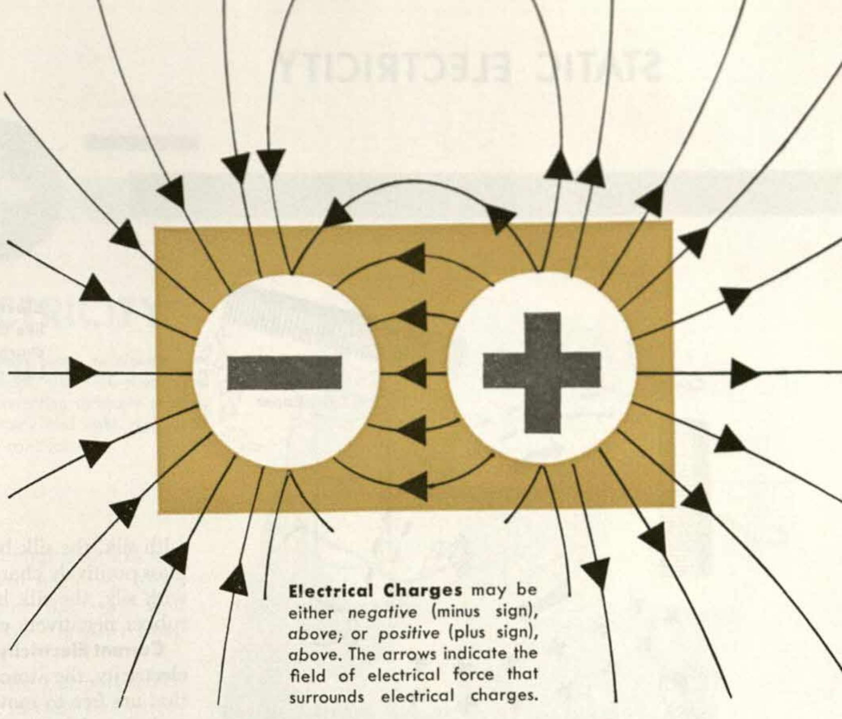
In Homes. Electricity serves more than 90 of every 100 homes in the United States, and more than 80 of every 100 homes in Canada. Electric irons, dishwashers, washing machines, driers, vacuum cleaners, and lawn mowers save hours of labor. Housewives prepare meals quickly and easily with electric stoves, ovens, toasters, grills, and food mixers. Refrigerators and freezers keep food fresh. Electric fans and air conditioners cool homes in summer. Electric blankets provide warmth for sleeping in winter. Many men shave with electric razors, and use electric saws, drills, and other power tools for "do-it-yourself" projects. See APPLIANCES.

In Business and Industry. Modern industry could not exist without electricity. Electric motors run drills, lathes, milling machines, and other tools. These tools mass-produce parts for products that are quickly assembled on electrically operated conveyer belts. Electricity melts and welds metals. It puts gold and silver plating on silverware, jewelry, and other objects. Powerful electric cranes lift huge loads. Delicate electronic instruments measure the thickness of steel to within millionths of an inch. Electricity runs elevators and escalators, or moving stairs, in stores and office buildings. Electric signs advertise products and businesses. Adding machines, computers, and other electrical devices save office workers time and effort.

On Farms, electricity lights homes and barns. Electric pumps supply water from wells. Many dairy farmers milk their cows with electric milking machines. Livestock farmers often protect their herds in fields surrounded by electrified fences. Farmers who raise chickens frequently use electric heaters to keep baby chicks warm. An electric timer may turn on the lights in the henhouse before dawn to awaken the chickens so they will start laying eggs.

In Communication. Radio, television, telephone, and telegraph link people in almost every part of the world. Radar, sonar, and other warning devices that use electricity help defend the United States, Canada, and other countries. Teletypes and facsimile equipment bring news stories and photographs to newspaper offices from

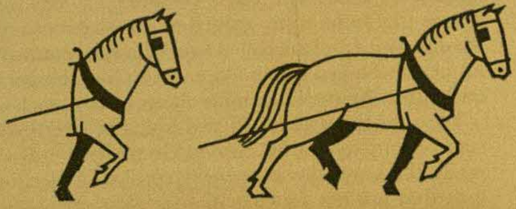
Electricity is one of the most useful forms of energy known to man. As indicated *above*, it produces light, heat, and the power to operate machines. All matter, starting with tiny electrons and atoms, is basically electrical.



Electrical Charges may be either *negative* (minus sign), *above*; or *positive* (plus sign), *above*. The arrows indicate the field of electrical force that surrounds electrical charges.

The Work Electrical Energy Does is measured in kilowatt-hours. A kilowatt-hour is 1,000 watts of electricity used for 1 hour. One thousand watts equals 1.34 horsepower.

Modern Industry could not exist without electric power. Every American industrial worker has 8½ kilowatts of electricity working for him throughout the working day.



distant places. Teletypesetters can set news stories in type as they arrive. Electricity helped make the printing plate that printed the page you are now reading.

In Transportation. Electric streetcars and trolley buses carry millions of persons to work and school every day. Many cities have swift electric elevated or subway trains. Motor vehicles with spark plugs use electric sparks to explode the gasoline that runs their engines. Sleek diesel-electric locomotives pull most railroad trains. Diesel-electric engines also power many ocean liners and freighters.

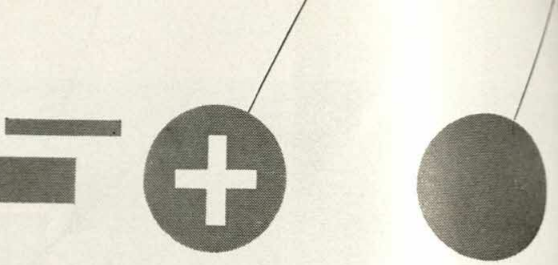
In Science, nearly all research apparatus depends on electricity. The small radios and measuring devices carried by artificial satellites work by electricity. So do the giant radio telescopes that astronomers use to study the sky. Atom smashers help uncover the secrets of the atom. Electricity creates the invisible ultraviolet and infrared rays used to treat various illnesses. Doctors photograph the inside of the body and treat diseases with X rays generated by electricity. They use electrically operated electroencephalographs to record the electric currents produced by the brain. Electric-shock treatments help restore the health of some mentally-ill persons (see SHOCK TREATMENT). Dentists use electric drills to fix cavities in teeth.

Basic Principles of Electricity

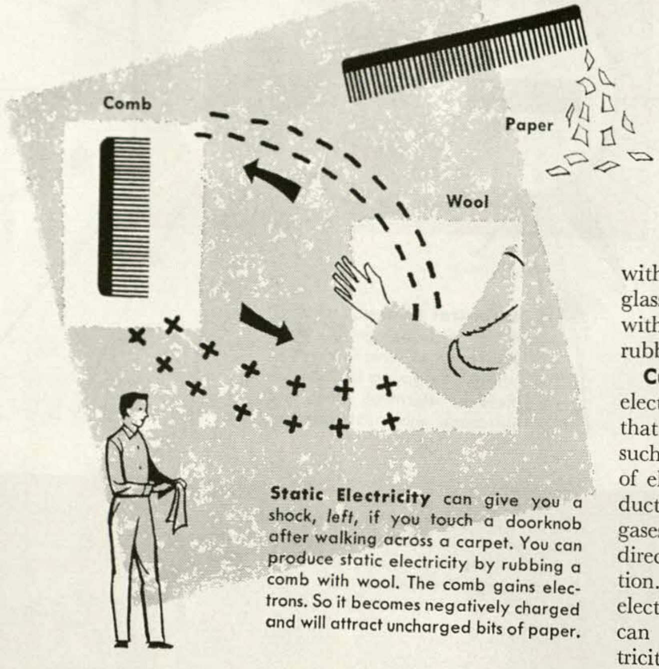
Everything is basically electrical. All matter consists of *atoms*. Each atom has one or more electrons and one or more protons. An *electron* is a negative particle of electricity. A *proton* is a positive particle of electricity. These tiny particles always have equal, but opposite, charges of electricity. Protons are heavier than electrons, however, and are bound tightly to the centers of atoms. Only electrons can move freely.

Ordinarily, an atom is *neutral*. This means that it has an equal number of electrons and protons. If an atom gains some electrons, it becomes *negatively charged.* If an

STATIC ELECTRICITY



Electrical Charges behave in set ways. Unlike charges, *left above*, attract each other. A charged body also attracts an uncharged one. Like charges, *right above*, repel each other.



Static Electricity can give you a shock, *left*, if you touch a doorknob after walking across a carpet. You can produce static electricity by rubbing a comb with wool. The comb gains electrons. So it becomes negatively charged and will attract uncharged bits of paper.

atom loses some electrons, it becomes *positively charged*. Atoms that have either gained or lost electrons are *electrically charged* and are called *ions*. Charged atoms always attract uncharged atoms. Atoms with like charges repel each other. Atoms with unlike charges attract each other.

We sometimes think of two kinds of electricity: (1) static electricity and (2) current electricity. But both are really the same. *Static electricity* consists of electrons or ions that are not moving. *Current electricity* consists of moving electrons or ions. Current electricity produces important magnetic effects. To understand electricity, you must also know something about the relation of *electricity and magnetism*.

Static Electricity makes your hair crackle when you comb it. Or it may give you a shock if you touch another person or a metal doorknob after walking across a carpet on a cold day. Static electricity has few uses compared with current electricity. You can produce static electricity by rubbing a comb with a piece of wool. The atoms in the wool lose some of their electrons, and the atoms in the comb gain them. So the comb becomes negatively charged and the wool becomes positively charged. To show that a charged object attracts an uncharged object, hold the comb near some bits of paper. The comb attracts the paper, which has no charge. You can produce a negative charge on a balloon by rubbing it against your hair. The balloon will stick to a wall or the ceiling, which are uncharged.

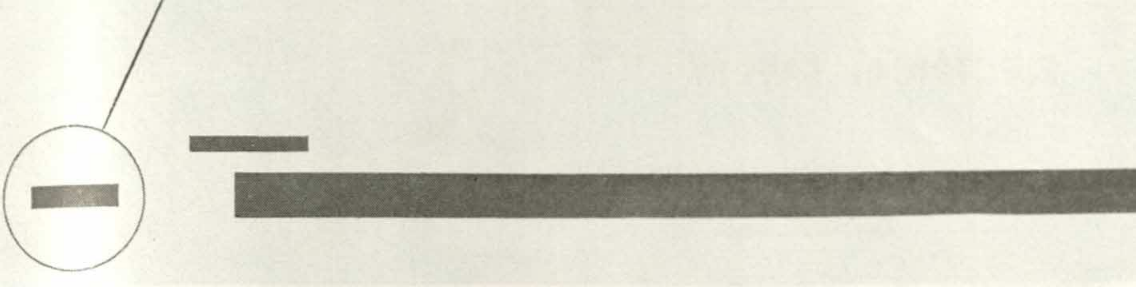
A substance does not always have the same charge when rubbed. For example, if you rub a piece of glass with silk, the silk becomes negatively charged and the glass positively charged. But if you rub a piece of rubber with silk, the silk becomes positively charged and the rubber negatively charged.

Current Electricity works for man. In order to conduct electricity, the atoms of a substance must have electrons that are free to move from atom to atom. Metals have such *free electrons*, and so metals make good *conductors* of electricity. Only the electrons move in metal conductors. Ions make up the electric current in liquids and gases that conduct electricity. Positive ions flow in one direction, and negative ions flow in the opposite direction. In some materials, such as rubber and glass, the electrons are bound so tightly to their atoms that few can move. These materials conduct hardly any electricity. Therefore, they are known as *nonconductors*, or as *insulators* or *dielectrics*.

Electrons are among the smallest known particles. In a 60-watt light bulb, for example, about 3,000,000,000,000,000,000 (three billion billion) electrons a second flow past any point in the wires to the bulb. These electrons travel from atom to atom in the wires at a speed of a few inches every second. But *electrical energy*, or the ability of electricity to do work, travels through a wire almost as fast as the speed of light, which is 186,282 miles a second. When you speak into a telephone, the person to whom you are talking hears your voice almost instantly. Electric current in a wire works much like a 100-foot long hose filled with water. If you connect the hose to a faucet and turn the water on and off, spurts of water come out of the far end of the hose almost immediately. You will have sent a signal 100 feet, although any drop of water in the hose will have moved only a few inches.

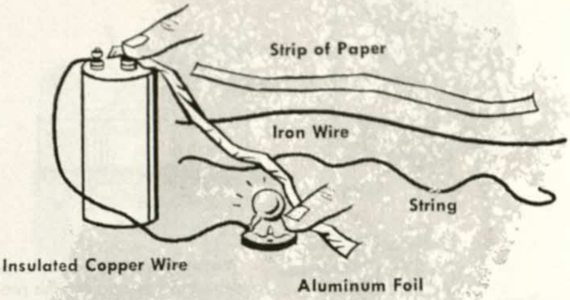
The flow of electric current and of water both depend on three factors: (1) the pressure that causes the current to flow, (2) the rate of flow, and (3) the resistance of the conductor (wire or hose) to the flow. Both flows also produce power. That is, they can do work. In electricity, the units used to measure these factors are *volts* for pressure; *amperes* for the amount, or rate, of current flow; *ohms* for resistance; and *watts* for power. See ELECTRIC MEASUREMENT; VOLT; AMPERE; OHM; WATT.

Electrons travel through any conductor from a negative source to a positive source of electricity. Benjamin Franklin guessed wrongly that electricity travels from positive to negative. This belief was accepted for many



CURRENT ELECTRICITY

A flow of free electrons forms an electric current. To conduct current, materials must have free electrons. By connecting different materials between the battery and light, *right*, you can show which are conductors.



years, and electricians and electrical engineers still say that electricity flows from positive to negative. Most electrical diagrams show current flow this way. But scientific tests prove that electrons flow the other way, from negative to positive.

There are two main kinds of electric current: direct and alternating. *Direct current* flows in only one direction. *Alternating current* rapidly reverses its direction of flow many times a second. See ELECTRIC CURRENT.

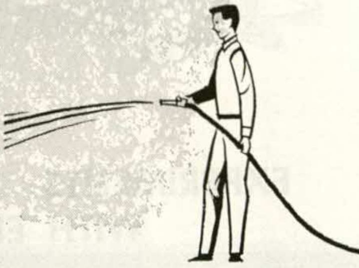
Electricity and Magnetism are closely related. The area around a magnet where its force can be felt is called a *magnetic field*. Electricity flowing through a wire sets up a magnetic field about the wire. Also, a magnetic field can produce electricity in a wire. If you move a wire so that it cuts across a magnetic field, electricity will be generated in the wire. All electric generators work on this principle. See ELECTRIC GENERATOR; MAGNET AND MAGNETISM.

If you wind a wire conducting electricity into a coil, it will have two poles, just as an iron magnet does. *Poles* are the areas where the force of a magnetic field is strongest. You can increase the magnetic strength of a coil of wire by putting a piece of iron inside it. Iron conducts magnetic force better than air does. Telephones and doorbells work by means of such *electromagnets*. See ELECTROMAGNETISM.

How Electricity Is Produced

Batteries change chemical energy to electricity. An automobile battery, for example, has metal plates coated with oxides of lead in a container of sulfuric acid (see OXIDE). The action of the acid on the plates produces electricity. Dry-cell batteries, such as those used in flashlights, usually have a container of zinc filled with a damp paste of ammonium chloride and manganese dioxide. This paste surrounds a carbon rod. The batteries are called *dry cells*, even though the paste must be slightly moist or the battery will not work. See BATTERY.

Generators. Moving a magnet past a coil of wire *induces*, or produces, an electric current in the wire. Electric generators produce most of the world's electricity by whirling powerful magnets past coils of copper bars. In some generators, the magnets are stationary and the coils of wire or bars move. But the principle is the same. Some airplanes and tractors have an electric generator, called a *magneto*, that works in this way (see MAGNETO). A large electric generator turned by a steam turbine may have several hundred thousand horsepower.



Electric Current in a wire works much like water in a hose. Turn a hose on and off. Water comes out immediately. But individual drops of water move only a short distance in the hose. Electrical energy works almost instantly, but free electrons in a wire move only a few inches a second.

By Other Means. Devices other than batteries and generators can produce small amounts of electricity. The *thermocouple* changes heat energy to electricity. A thermocouple has two wires of different materials, such as iron and nickel, that are firmly joined at each end. If one joint is heated, electricity flows around the circuit formed by the two wires. These devices are used chiefly to measure temperature (see THERMOCOUPLE). A *photoelectric cell*, or *electric eye*, changes light energy to electricity. It has sensitive materials that give off electrons when light strikes them. A camera light meter is a photoelectric cell. So are the solar batteries that supply electricity to run radios and scientific equipment in artificial satellites. See ELECTRIC EYE; SOLAR ENERGY (Solar Batteries).

Transmission and Control of Electricity

Transmitting Electricity. Systems of wires called *circuits* transmit electricity. A simple circuit consists of only two wires. One wire conducts the electricity from the place where it is generated to the place where it is used. The other wire conducts the electricity back to the generating point. A generator or battery might be compared with a pump, and the circuit with a closed system of water pipes. The generator or battery keeps electricity circulating through the circuit. In a flashlight, for example, electricity flows from one *terminal*, or end, of a battery to a light bulb, through a wire in the

ELECTRICAL SAFETY

Electricity can be both a friend and a foe. Using the wrong fuse or running an extension cord under a rug can cause household fires.

Water lowers the body's resistance to current. For this reason, never touch anything electrical if your hands or feet are wet, or while bathing.

light bulb, then back to the other terminal of the battery. Vast *grids*, or networks, of wires carry most of the electricity that we use. The electricity is produced by powerful generators in electric-power stations. These networks are very complex compared with the simple circuit in a flashlight, but they work in exactly the same way. See Electric Power.

Controlling Electricity. An electric circuit must be complete in order for electricity to flow. If a break occurs in the circuit at any point, electricity will not flow. All circuits have such breaks, called *switches*. When the switch is *open*, or off, no electricity flows. When the switch is *closed*, or on, it completes the circuit, and electricity flows (see Electric Switch). Most circuits are designed to carry only a certain amount of current. They have devices called *fuses* that break the circuit if too much electricity flows through it (see Fuse, Electric).

Other ways of controlling electricity include transformers, rheostats, and condensers. A *transformer* increases or decreases the voltage of alternating current by means of induction. Transformers have no moving parts, and are a cheap and simple way of raising or lowering the voltage of alternating current. This is why practically all electric-power systems in the United States supply alternating current. See Induction, Electric; Transformer.

A *rheostat* is a device that increases or decreases the amount of resistance in an electrical circuit. The higher the resistance, the smaller the amount of current that can flow. Rheostats can be used to dim lights and to control the speed of electric machines. See Rheostat.

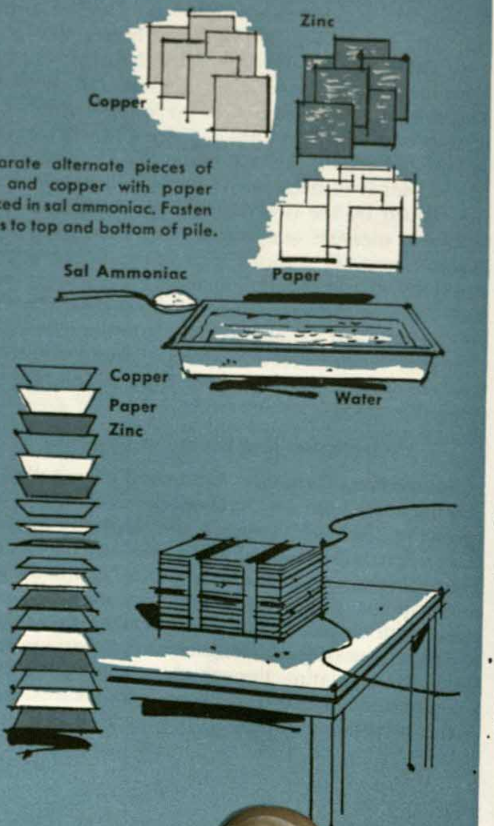
A *condenser*, or *capacitor*, stores static electricity until it is needed. See Condenser.

How to Use Electricity Safely

Electricity can be both a friend and a dangerous enemy. If you are careless, electricity can kill you in a second. High voltage can force a large amount of elec-

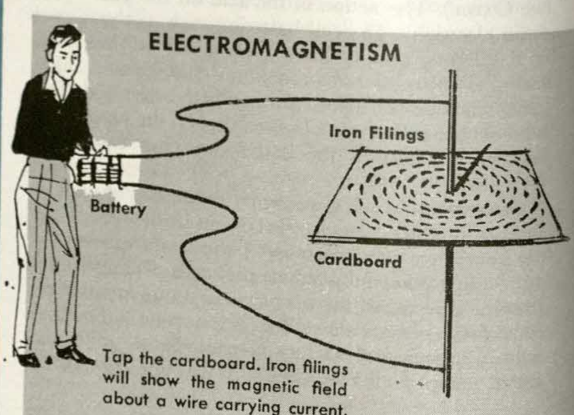
EXPERIMENTS WITH ELECTRICITY

A SIMPLE BATTERY

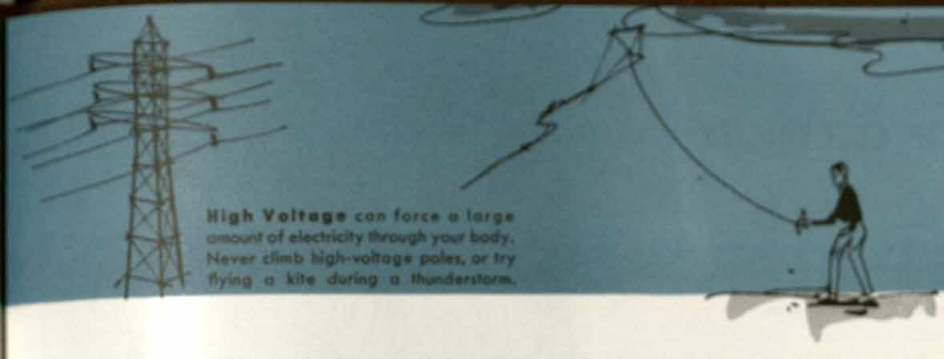


Separate alternate pieces of zinc and copper with paper soaked in sal ammoniac. Fasten wires to top and bottom of pile.

ELECTROMAGNETISM



Tap the cardboard. Iron filings will show the magnetic field about a wire carrying current.



High Voltage can force a large amount of electricity through your body. Never climb high-voltage poles, or try flying a kite during a thunderstorm.

tricity through a human body, even if the resistance of the body is high. For this reason, a high-voltage electric current is *always* dangerous. Water lowers resistance, because it is a good conductor of electricity. Even low-voltage current, such as the 120-volt current in the average house, can kill you if you touch a bare wire with wet hands or while standing on a wet floor. Here are a few simple rules for the safe use of electricity:

Never touch anything electrical when your hands or feet are wet.

Never touch a radio or any other electrical appliance while you are in a bathtub.

Never put a penny or any other conducting material under a burned-out fuse. This may allow too much current to enter the circuit, and cause a fire. Always use the proper size fuse for the circuit involved (many household circuits require 15-ampere fuses).

Never run an electric extension cord or any other electric wire under a rug. If the insulation on the wire wears off, a short circuit might occur that could cause a fire.

Never climb a pole marked "High Voltage."

Never fly a kite near transmission lines or during an electrical storm. Benjamin Franklin was unusually lucky when he performed his kite experiment to show that lightning is electricity.

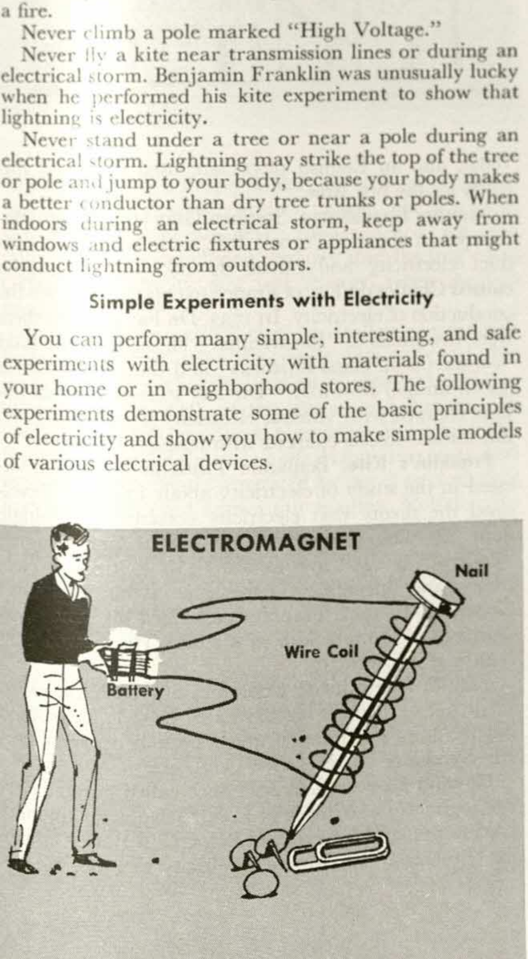
Never stand under a tree or near a pole during an electrical storm. Lightning may strike the top of the tree or pole and jump to your body, because your body makes a better conductor than dry tree trunks or poles. When indoors during an electrical storm, keep away from windows and electric fixtures or appliances that might conduct lightning from outdoors.

In Electrical Storms, never stand under trees or by open windows. Lightning may strike them and jump to your body, because it makes a better conductor than a tree or window.

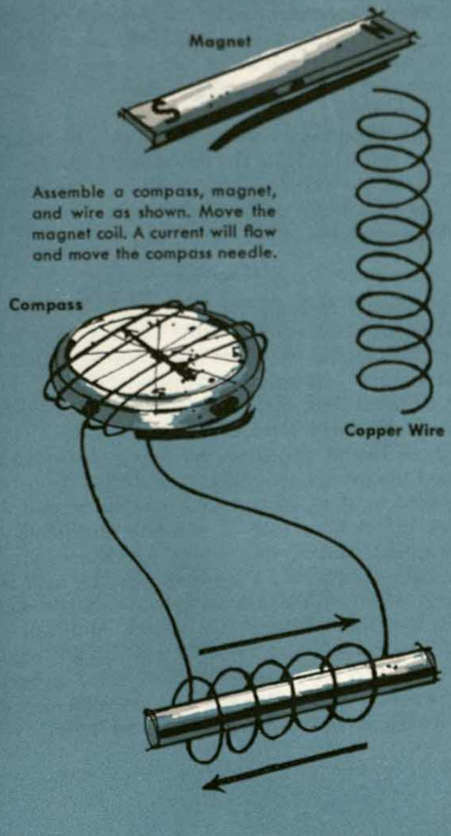
Simple Experiments with Electricity

You can perform many simple, interesting, and safe experiments with electricity with materials found in your home or in neighborhood stores. The following experiments demonstrate some of the basic principles of electricity and show you how to make simple models of various electrical devices.

ELECTROMAGNET



A SIMPLE GENERATOR

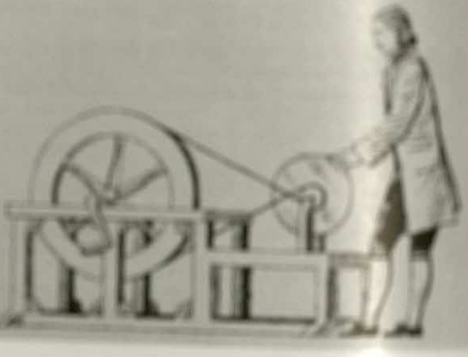


Assemble a compass, magnet, and wire as shown. Move the magnet coil. A current will flow and move the compass needle.

HISTORY OF ELECTRICITY

Pioneer scientists from the 1600's to the early 1800's took the first important steps in the conquest of electricity. Shown, right, are some of these men and their discoveries.

William Gilbert, above, physician to England's Queen Elizabeth I, described the attraction of amber in 1600. About 1660, Otto von Guericke of Magdeburg, Germany, below, built the first static-electric machine.



A Simple Battery. Cut about six pieces each from a thin sheet of copper, a sheet of zinc or galvanized iron, and a strip of blotting paper or cloth. All the pieces should be about 3 inches square. Soak the blotting paper or cloth in a pan containing half a glass of water and a spoonful of ammonium chloride, commonly called sal ammoniac. Then pile the pieces in this order: copper, paper, zinc; copper, paper, zinc; and so on. Press the pile firmly together and fasten wires to the top and bottom plates. You have now built a type of battery called a *voltaic pile*. If you connect the wires to a doorbell, the bell will ring. See ELECTRIC BELL.

Electromagnetism. Run a wire through a piece of cardboard on which iron filings have been sprinkled. Connect the two ends of the wire to your voltaic pile battery so a current flows through the wire. Then tap the cardboard. The iron filings will form circles about the wire. These circles show the shape of the magnetic field surrounding the wire.

You can make an *electromagnet* by winding about 100 turns of insulated copper wire around an iron nail that is 4 to 6 inches long. Connect the two ends of the wire to your voltaic pile so a current flows through the wire. The nail will then attract other small iron objects.

A Simple Generator can be made from a permanent magnet, a small magnetic compass, and about 25 feet of fine copper wire. Wrap about half the wire around the compass and you will have a *galvanometer*, a device for detecting current. Wind most of the other half of the wire into a coil large enough to slip over the magnet. Connect the wires from the galvanometer to the coil. Now move the coil back and forth over the magnet. The compass needle will move, showing that a current has been produced.

History

Man began to learn about electricity hundreds of years before the birth of Christ. Thales of Miletus, a Greek philosopher who lived about 600 B.C., rubbed a piece of amber with a cloth and observed that the amber then attracted bits of feathers and the pith of plants.

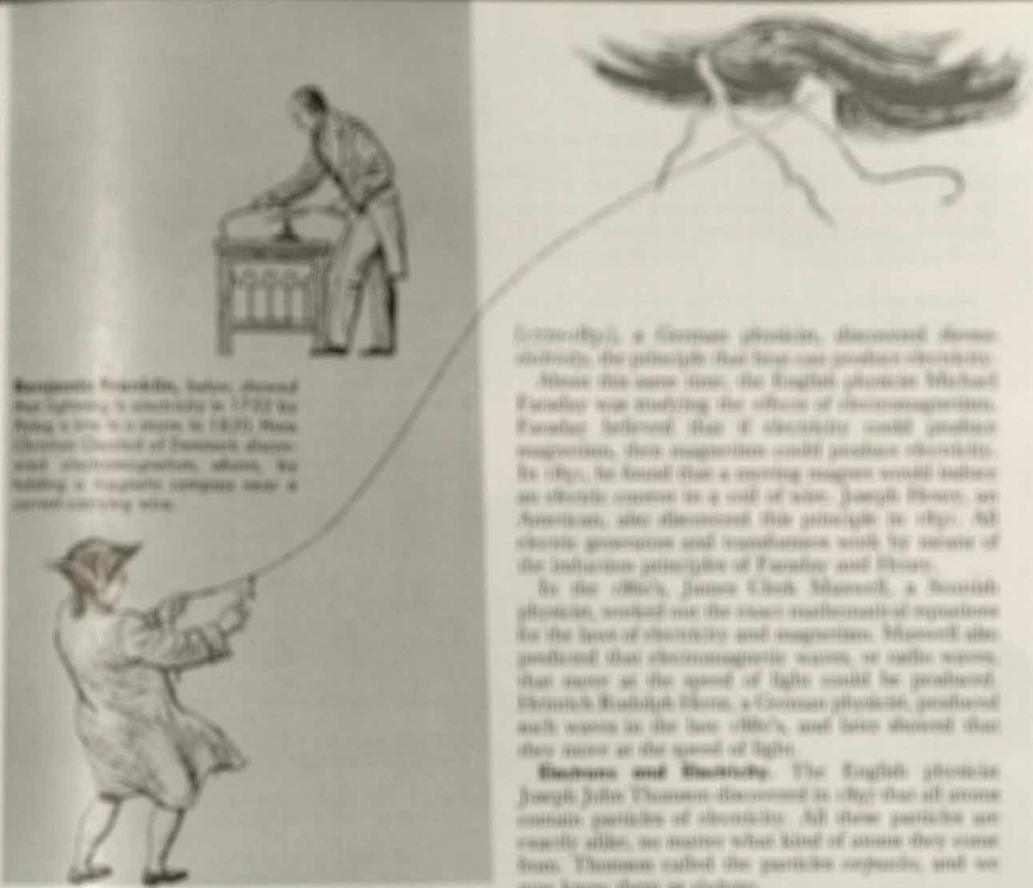
Learning About Electricity. William Gilbert (1540-1603), an English physician, made one of the first important discoveries about static electricity. In a book published in 1600, Gilbert told how the attraction of amber differs from that of magnetic lodestones (see LODESTONE). Amber, when rubbed with a cloth, attracts only light objects, while lodestones attract only iron. Gilbert also found that other substances, such as sulfur, glass, and resin, behave like amber. Our word for electricity comes from *elektron*, the Greek word for amber. Gilbert used *electrum*, the Latin word for amber, and made up the word *electrica* for other substances that behave like amber. In 1646, Sir Thomas Browne (1605-1682), also an English physician, used the word *electricity* for the first time.

Another Englishman, Stephen Gray (1666-1736), discovered in the early 1700's that some substances conduct electricity and others do not. His discoveries caused Charles du Fay of France to experiment with the conduction of electricity. In 1733, Du Fay thought there were two kinds of "Electricities." He named one kind "vitreous (as on glass) *Electricity*" and the other "resinous (as on amber) *Electricity*." Du Fay learned that all objects charged with vitreous electricity repel each other, but attract objects charged with resinous electricity.

Franklin's Kite. Benjamin Franklin became interested in the study of electricity about 1746. He developed the theory that electricity consisted of a single fluid. He first used the terms *positive* and *negative*. "Positive" is the same as Du Fay's "vitreous" electricity, and "negative" is the same as his "resinous" electricity. In 1752, Franklin performed his famous experiment of flying a kite in a storm. He showed that lightning is electricity.

Charles Augustin de Coulomb, a French physicist, made one of the next big advances. In 1785, he worked out the laws of attraction and repulsion between electrically charged bodies. See COULOMB.

Flowing Electricity. People once called current electricity *galvanism* in honor of Luigi Galvani, an anatomy professor at the University of Bologna in Italy. Galvani experimented with current electricity in 1786. He [illegible]



Benjamin Franklin, below, showed that lightning is electricity in 1752 by flying a kite in a storm. In 1820, Hans Christian Oersted of Denmark discovered electromagnetism, above, by holding a magnetic compass near a current-carrying wire.

tened the legs of a freshly killed frog to a copper hook, and hung the hook over an iron railing. The frog's legs twitched violently whenever they touched the iron railing. Galvani concluded wrongly that the frog's legs contained electricity that was released when the legs touched metal.

In 1800, Alessandro Volta, an Italian physics professor, discovered why the frog's legs twitched. He learned that the chemical action of moisture and two different metals, such as the copper and iron in Galvani's experiment, produced electricity. Volta built the first battery, called the *voltaic pile*. He made it of stacked copper and zinc plates separated by paper or cloth that had been moistened with a salt solution. Voltaic piles were the first sources of steady electric current.

Hans Christian Oersted, a Danish scientist, discovered electromagnetism in 1820. Oersted learned that a current flowing through a wire would move a compass needle. This showed that an electric current has a magnetic effect.

In the same year, the French physicist André Marie Ampère measured the magnetic effect of an electric current. Ampère learned that two wires that are carrying current attract and repel each other just as magnets do. By 1822, Ampère had worked out the laws that formed the basis for the science of current electricity. In 1826, Georg Simon Ohm, a German schoolteacher, formulated the law of electrical resistance that bears his name (see OHM'S LAW). Also in 1826, Thomas Johann Seebeck (1770-1831), a German physicist, discovered thermoelectricity, the principle that heat can produce electricity.

About this same time, the English physicist Michael Faraday was studying the effects of electromagnetism. Faraday believed that if electricity could produce magnetism, then magnetism could produce electricity. In 1831, he found that a moving magnet would induce an electric current in a coil of wire. Joseph Henry, an American, also discovered this principle in 1831. All electric generators and transformers work by means of the induction principles of Faraday and Henry.

In the 1860's, James Clerk Maxwell, a Scottish physicist, worked out the exact mathematical equations for the laws of electricity and magnetism. Maxwell also predicted that electromagnetic waves, or radio waves, that move at the speed of light could be produced. Heinrich Rudolph Hertz, a German physicist, produced such waves in the late 1880's, and later showed that they move at the speed of light.

Electrons and Electricity. The English physicist Joseph John Thomson discovered in 1897 that all atoms contain particles of electricity. All these particles are exactly alike, no matter what kind of atoms they come from. Thomson called the particles *corpuscles*, and we now know them as *electrons*.

Thomson's discovery helped make possible the electronic age in which we live. Soon afterward, John A. Fleming, a British scientist, built a vacuum tube that could detect radio signals. In 1907, Lee De Forest, an American, invented a vacuum tube that amplified radio signals. These tubes made radio possible. The development of other vacuum tubes led to the invention of television in the 1920's, of radar in the 1930's, and of electronic computers in the 1940's. For an account of these developments, see ELECTRONICS (History).

In the 1950's, American and British scientists harnessed the power of atomic energy to generate electricity. A nuclear reactor built at Arco, Ida., powered a generator that produced the first electricity from atomic energy in 1951. In 1959, American scientists reported they had changed the heat from a nuclear reactor directly into electricity with a type of thermocouple, called a *plasma thermocouple*, made of cesium gas and uranium.

Careers in Electricity

The two chief kinds of careers in electricity are as (1) electricians or (2) electrical engineers. Electricians are skilled craftsmen who install, maintain, and repair electrical equipment such as electric stoves, motors, radios, or the wiring in a house. Electrical engineers may design electrical apparatus, teach in schools and colleges, or do research for industrial firms and colleges. Electrical engineers often rise to executive positions in industry.

An electrical engineer needs a college degree. Persons interested in such a career should study algebra, geometry, trigonometry, physics, and chemistry in high school. A person interested in a career as an electrician should also take these kinds of courses in high school. He can then attend a technical school for training in telephony, motor repair, television, or whatever field he wants to enter.

HUGH HILDRETH SKILLING

Related Articles. See the heading Electronics in the PHYSICS section of the READING AND STUDY GUIDE for a list of electronic devices. See also the following articles:

BIOGRAPHIES

Ampère, André Marie
Bell, Alexander Graham
Coulomb, Charles A. de
Davy, Sir Humphry
De Forest, Lee
Du Fay, Charles François
Edison, Thomas A.
Faraday, Michael
Franklin, Benjamin
Galvani, Luigi
Gauss, Karl Friedrich
Gray, Elisha
Henry, Joseph
Hertz, Heinrich R.
Kelvin, Lord
Marconi, Guglielmo
Maxwell, James C.
Millikan, Robert A.
Morse, Samuel F. B.
Oersted, Hans C.
Ohm, Georg S.
Thales
Thomson, Sir Joseph J.
Volta, Count
Zworykin, Vladimir K.

WAYS OF USING ELECTRICITY

Air Cleaner
Air Conditioning
Appliances
Automobile (Electrical System)
Cable
Dynamotor
Electric Bell
Electric Blanket
Electric Car
Electric Fan
Electric Furnace
Electric Light
Electric Motor
Electric Railroad
Electric Sign
Electromagnet
Electroplating
Electrotyping
Elevated Railroad
Elevator
Flashlight
Heating (Electric Heating)
Ignition
Light Meter
Lightning Rod
Locomotive
Loudspeaker
Public Address System
Radar
Radio
Refrigeration
Searchlight
Streetcar
Telegraph
Telephone
Television
Thermocouple
Ultrafax
Vacuum Cleaner
Washing Machine
Welding

BASIC PRINCIPLES AND WAYS OF PRODUCING ELECTRICITY

Atom
Attraction
Battery
Capacitance
Electric Arc
Electric Current
Electric Eye
Electric Field
Electric Generator
Electrochemistry
Electrolysis
Electrolyte
Electromagnetism
Electromotive Force
Electromotive Series
Electron
Inductance
Induction, Electric
Induction, Electromagnetic
Ionization
Magnet and Magnetism
Magneto
Matter
Piezoelectricity
Thermoelectricity

CONTROLLING AND MEASURING ELECTRICITY

Ampere
Circuit Breaker
Condenser
Converter
Coulomb
Electric Measurement
Electric Meter
Electric Switch
Electric Wiring
Electroscope
Farad
Fuse, Electric
Galvanometer
Ground (electrical)
Induction Coil
Insulator, Electric
Kilowatt
Leyden Jar
Ohm
Ohm's Law
Potentiometer
Rheostat
Solenoid
Transformer
Volt
Voltmeter
Watt

UNCLASSIFIED

Atomic Energy
Chemistry
Electric Eel
Electric Fish
Electric Power
Electrician
Electrocution
Energy
Engineering (Electrical Engineering)
Glass (Kinds of Glass in Everyday Life)
Light
Loadstone
Physics
Rural Electrification Administration
Safety (Safe Use of Electricity)
Torpedo, or Electric Ra
Turbine
Water Power

Outline

- **I. Uses of Electricity**
  - A. In Homes
  - B. In Business and Industry
  - C. On Farms
  - D. In Communication
  - E. In Transportation
  - F. In Science
- **II. Basic Principles of Electricity**
  - A. Static Electricity
  - B. Current Electricity
  - C. Electricity and Magnetism
- **III. How Electricity Is Produced**
  - A. Batteries
  - B. Generators
  - C. By Other Means
- **IV. Transmission and Control of Electricity**
  - A. Transmitting Electricity
  - B. Controlling Electricity
- **V. How to Use Electricity Safely**
- **VI. Simple Experiments with Electricity**
- **VII. History**
- **VIII. Careers in Electricity**

Questions

What kind of electricity do you generate when you comb your hair?

What is a negative particle of electricity called? A positive particle?

What is a *galvanometer* used for? How can you make a simple one?

What theory did Benjamin Franklin develop about electricity?

What are the laws of attraction and repulsion?

What is the difference between static and current electricity?

How is electricity used in the engines of motor vehicles? What other vehicles run on electricity?

How do physicians use electricity in their work?

What are a few safety rules in using electricity?

What makes a material a conductor? An insulator?

Books for Young Readers

BEELER, NELSON F., and BRANLEY, F. M. *Experiments with Electricity*. Crowell, 1949. Simple experiments presented through diagrams and clear explanations.

BISHOP, RICHARD W. *Stepping Stones to Light*. Crowell, 1952. Historical background and short sketches of the most important figures in the field of electricity.

EPSTEIN, SAMUEL, and WILLIAMS, BERYL. *The First Book of Electricity*. Watts, 1953.

FERAVOLO, ROCCO V. *Junior Science Book of Electricity*. Garrard, 1960.

MANDELBAUM, ARNOLD. *Electricity: The Story of Power*. Putam, 1960. A survey from 600 B.C. to the present.

MORGAN, ALFRED P. *First Electrical Book for Boys*. Rev. ed. Scribner, 1951.

VAN DE WATER, MARJORIE. *Edison Experiments You Can Do: Based on the Original Notebooks of Thomas Alva Edison*. Harper, 1960.

Books for Older Readers

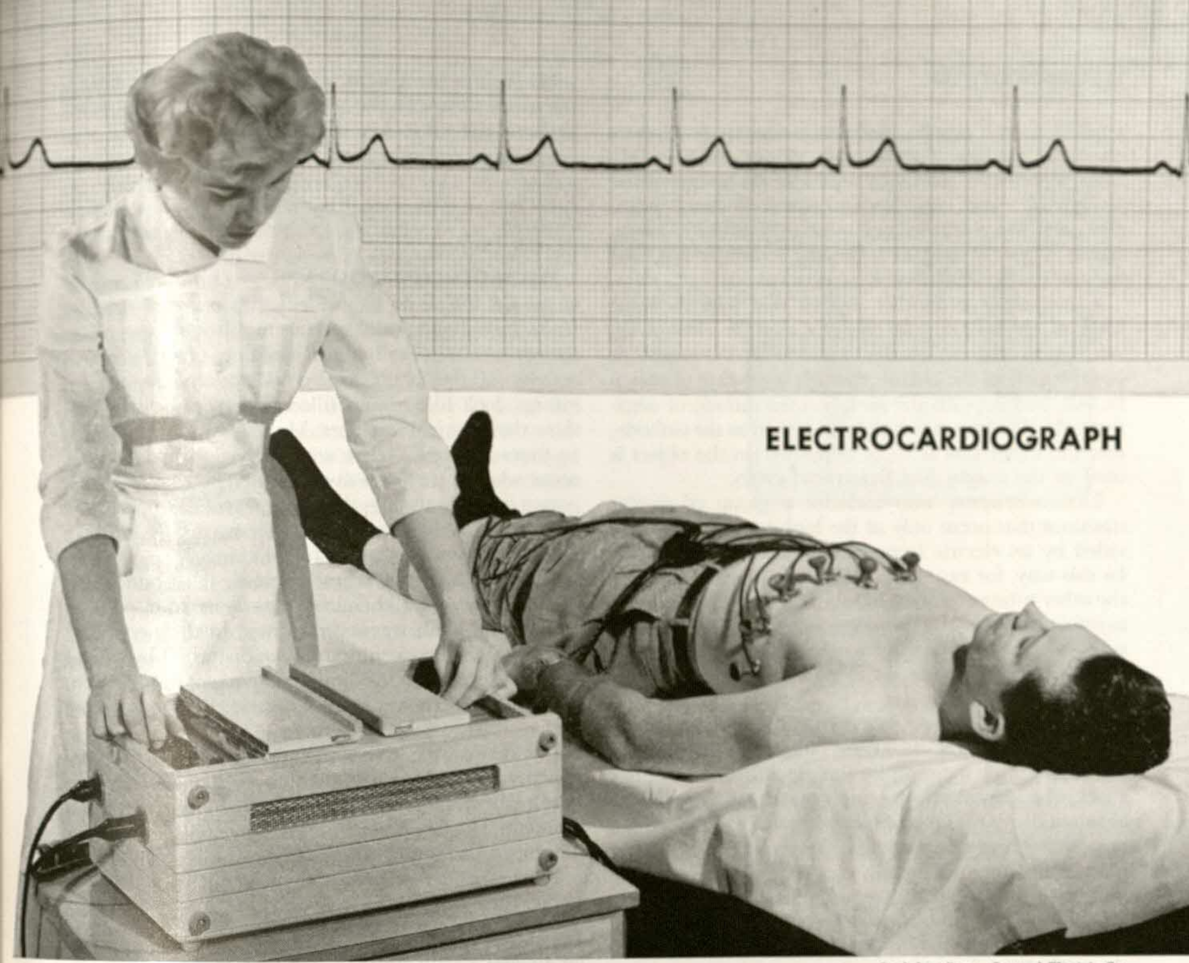
DOAN, WILLARD. *Experimental Electricity for Boys*. Rider, 1959. Experiments which range widely in subject and require background and experience.

GRAHAM, KENNARD C. *Fundamentals of Electricity*. 4th ed. rev. American Technical Society, 1960.

KENNEDY, JOHN M. *Making Electricity Work*. Crowell, 1959. An explanation of electricity and magnetism with directions for making simple and useful devices.

SHIPPEN, KATHERINE B. *The Bright Design*. Viking, 1949. The development of electrical energy traced through the biographies of important scientists.

STEINBERG, WILLIAM B., and FORD, W. B. *Electricity and Electronics: Basic*. American Technical Society, 1961. An introduction for the layman.



ELECTROCARDIOGRAPH

Beck-Lee Corp., General Electric Co.

The Electrocardiograph detects and records the electrical impulse which develops in the heart and spreads through its muscles with each heartbeat. In the direct-writing type of electrocardiograph, the current arising in the heart is greatly amplified and used to move a writing arm. The movements of the arm make an *electrocardiogram*, a record in ink on paper.

ELECTRIFICATION, RURAL. See Rural Electrification.

ELECTROCARDIOGRAPH, *ee* LECK *troh KAHR dih oh grahf*, is an instrument used to diagnose disorders of the heart. This instrument detects and records the electrical impulse that normally develops in the heart and spreads through its muscle with each beat. The electrocardiograph developed from the string galvanometer invented in 1903 by Willem Einthoven (see Einthoven, Willem; Galvanometer).

The recording made by an electrocardiograph is called an *electrocardiogram*, often abbreviated EKG. Impulses from the normal heart make records of a specific size and shape. In certain abnormal conditions, the recording shows changes in this pattern. Such changes often indicate that the person's heart muscle is diseased or that the walls that form the heart chambers have become thick. Electrocardiograms are made up of several sections that show the spread of the electrical impulse through the heart. If these elements do not follow in normal sequence, doctors know that the person's heart beats irregularly.

To make the recordings, electrical impulses from the heart are gathered at four points. Doctors usually place electrodes, which are attached to wires from the machine, on each of the patient's wrists, on his left leg, and on his chest. Some recordings are made by photographing a metal-coated quartz string or a wire coil bearing a mirror suspended in a magnetic field. Impulses from the heart move these objects. The movement is recorded on photosensitive paper by special optical systems. In other types of electrocardiographs, the heart impulses themselves are amplified and used to move a writing arm. Recordings are made by an inked stylus on paper or by a heated stylus on specially coated paper.

The first electrocardiograph, brought to America early in the 1920's, weighed more than a quarter of a ton. It was difficult to operate and to repair. Modern machines weigh 30 pounds or less. The control panel looks like that of a television set. Francis F. Rosenbaum

ELECTROCHEMISTRY is the study of ions in solution and of their action with metals (see Ionization). It also studies chemical reactions caused by passing an electric current through gases, liquids, and solids.

Electrochemistry has many important practical applications. It uses the principle that chemical and electrical energy can be interchanged. A battery uses chemical changes to produce electricity. Industries apply a reverse process, and use electricity to produce chemical changes. For example, under proper conditions, a current of electricity separates the hydrogen and oxygen in water. Another important electrochemical process is the electrolysis of brine to produce chlorine, which is widely used as a bleach, a disinfectant, and industrial chemical. See Electrolysis.

Electroplating is another process that uses the same kind of electrochemical changes used in electrolysis. An electric current carries metal from the *anode*, or positive pole of the circuit, through a solution of metallic salt, and deposits the metal on the *cathode*, or negative pole. The object to be plated is used as the cathode, and the metal that is to be deposited on the object is used as the anode. See Electroplating.

Electrochemistry also includes a group of similar reactions that occur only at the high temperatures provided by an electric furnace (see Electric Furnace). In this way, for example, aluminum is separated from the other substances in aluminum ores. Using electricity to refine metals is called *electrometallurgy*. Other valuable substances, such as carbides, phosphorus, silicon, and magnesium, are made by electrometallurgy in much the same way. James S. Fritz

See also Acetylene; Aluminum; Battery.

ELECTROCUTION, *ee* LEHK *troh KYOO shun*, is a means of killing a person by the use of a strong electric shock. Accidental electrocution occurs when a person accidentally comes in contact with, and is killed by, a powerful charge of electricity. Condemned prisoners in many states are intentionally electrocuted. The prisoner is brought into a special room called a *death chamber*, and strapped into an *electric chair*. Metal plates called *electrodes* are attached to the crown of his head and the calf of one leg. An electric current is then passed from one electrode to another through the prisoner's body. It is strong enough to produce immediate loss of consciousness and almost immediate death. Medical experts believe a person feels no pain in electrocution.

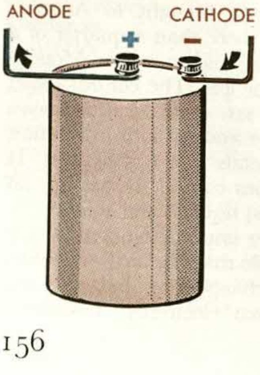
In 1889, New York became the first state to electrocute criminals. Most states require that the county sheriff, two physicians, one or two ministers, and a jury of 12 be present. The physicians conduct a medical examination immediately after the electrocution, to make sure the person executed is dead. Donald R. Cressey

See also Capital Punishment.

ELECTRODE, *ee LEHK trohd*, is the terminal of any electric source. The positive electrode is called the *anode*, and the negative electrode is called the *cathode*. Michael Faraday originally used the term electrode for either terminal in an electrolytic cell. Modern writers often use the term electrode to indicate the whole terminal of an electric cell, including its negative or positive surface.

The term also refers to the metallic parts of some vacuum and gas-filled tubes such as neon signs. These metallic parts provide the contact between the source of electricity outside the sign and the gas inside. Palmer H. Craig

The Electrode is a connection through which current enters or leaves a battery.



Related Articles in World Book include:

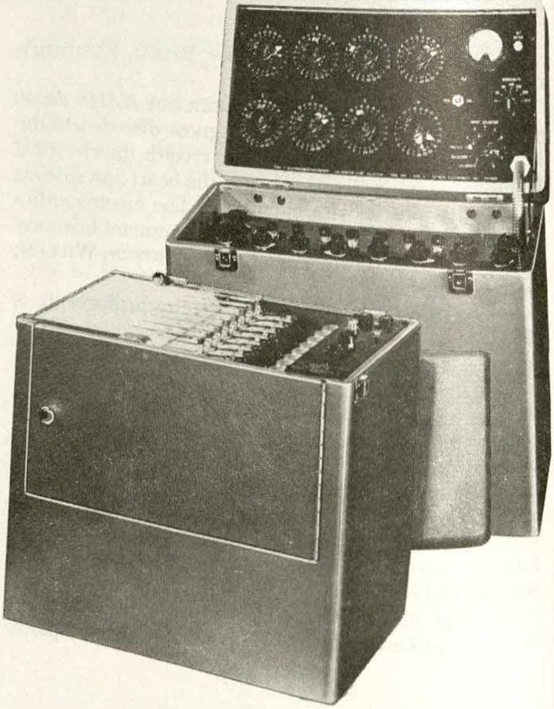
Anode
Arc Light
Cathode
Electric Current
Electrolysis
Faraday, Michael
Neon

ELECTROENCEPHALOGRAPH, *ee* LEHK *troh en SEF uh loh GRAFF*, is an instrument that measures and records the voltages, or electrical impulses, generated by the nerve cells in the brain. Recordings of the electrical activity of the brain, called *electroencephalograms*, or *tracings*, look like graphs filled with wiggly lines that show the electrical impulses. Most of the wiggles repeat 10 times a second. These are called *alpha waves*. They occur when a person is awake but relaxed. When the person is concentrating, the alpha waves disappear, and the recording shows smaller, faster waves. A newborn baby has almost no brain waves. During sleep, or sometimes when a person is unconscious, the brain waves become slow. The chemical generators that produce and control brain waves are located in the nerve cells of the brain. These centers may be disturbed by a head injury, infection of the brain, or not enough oxygen. When the centers are seriously upset, the brain waves are recorded in jagged forms.

Doctors use the electroencephalograph to diagnose epilepsy and to locate brain tumors. They also use it to tell whether a person's brain has been injured in an accident. The first practical electroencephalograph was developed in 1929 by Hans Berger of Germany. Modern instruments record from eight or more brain areas at one time. Frederic A. Gibbs

The Electroencephalograph measures and records the electrical current generated in the human brain. One box, lower *left*, makes the *electroencephalogram*, or graphic record, of the test. The other contains a control panel for operating the instrument.

Offner Electronics Inc.



ELECTROLYSIS, *ee LEK TRAHL ih sis,* is the process of breaking down liquid into other substances by sending an electric current through it. Liquids that conduct a current and go through this chemical change are called *electrolytes.* Electrolysis can be used to separate water into the gases hydrogen and oxygen.

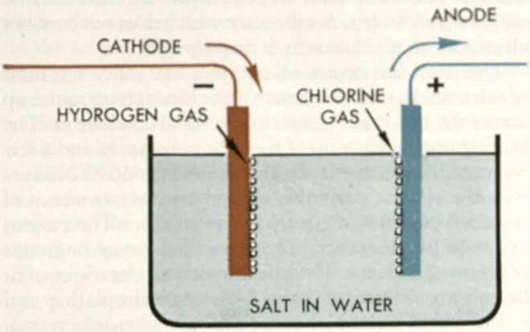
The Process. Electrolysis takes place in an *electrolytic cell,* a vessel in which two solid conductors, called the *electrodes,* are held in the electrolyte, but apart from each other. A solution of copper sulfate in water is a good electrolyte to use in a simple cell. The electrodes are two copper plates connected to an electric battery, or to some other source of direct current. The electrode attached to the positive pole of the battery is called the *anode,* and the one attached to the negative pole is the *cathode.* The current enters by the anode, passes through the electrolyte, and leaves by the cathode. If the current is allowed to pass through the cell for a time, and then the electrodes are removed, they appear different from each other. The anode looks tarnished, while the cathode looks bright and coppery. The reason for this difference is that copper has been eaten away from the anode, and deposited on the cathode in exactly the same amount.

Theory of Electrolysis. Experiments of this kind were performed by Michael Faraday, who discovered the laws of electrolysis. His explanation of the results was that the current breaks down the copper sulfate solution into electrified particles, and then carries them to the electrodes. Chemists for many years believed this theory. But today, they have a different explanation, called the *ionic dissociation* theory (see IONIZATION).

This theory begins with the nature of the electrolyte itself. Chemists point out that there are two different kinds of electrical conductors. The first kind includes the metals, while the second takes in the chemicals called *acids, bases,* and *salts,* either melted or dissolved in water. The second kind are the electrolytes. Many of the molecules of an electrolyte break up into parts, called *ions.* There are ions that have +, or *positive,* electrical charges, and others with −, or *negative,* charges. Ordinarily, the attraction of the opposite charges for each other holds the molecule together. But when the substance is either dissolved or melted, the ions separate from one another, or *dissociate.* Even before the current is turned on, the electrolyte is already broken up into electrified particles that are free to move around in the solution. The electric current then gives the anode a positive (+) charge, and the cathode a negative (−) charge. The anode (+) draws the − ions to it and at the same time the cathode (−) draws the + ions. Then the electrodes and the ions may act on each other and bring on the chemical changes. In the experiment with copper sulfate, the charges are explained as follows:

Copper sulfate ($CuSO_4$) is a compound of copper (Cu), sulfur (S), and oxygen (O). The copper forms the cupric ion (Cu^{++}), which carries positive electricity, while the sulfur and oxygen together form the sulfate ion (SO_4^{--}) carrying the negative charge. Positive charge means that Cu^{++} has lost two electrons and has fewer than usual. Negative charge means that SO_4^{--} has gained these electrons. When the electric current is turned on it pours extra electrons into the cathode, and draws electrons away from the anode. The anode (+) attracts the − ions, which have extra electrons to give up. At the same time, the + ions are attracted to the cathode (−), which also has electrons to give up. When a + ion reaches its electrode, it takes electrons away from it. The electric charge of the ion and electrode *neutralize* each other. As soon as this happens, Cu^{++} ion (which is part of the liquid) turns into the bright reddish solid we call copper. This is the extra copper that collects on the cathode. Meanwhile, the sulfate ion, SO_4^{--}, is going through chemical changes that take copper from the anode and form new copper sulfate.

How Electrolysis Takes Place



Laws of Electrolysis. Faraday discovered that the following things are always true of electrolysis:

(1) The power of the current to break down an electrolyte does not depend on the distance between the electrodes.

(2) The stronger the current, the more metal will be added to the cathode in a given length of time.

(3) When current of a given strength is passed through a solution, the amount of metal it deposits is in proportion to the *chemical equivalent* of the metal. The chemical equivalent is its atomic weight divided by its valence. See ATOM (Atomic Weight); VALENCE.

Industrial Uses. Electroplating is the use of electrolysis to deposit gold, silver, nickel, and other metals on cheaper ones. It is an essential part of manufacturing plated metalware and also the plates that are used in printing. Electrolysis also extracts pure aluminum from aluminum compounds, removes the tin coating from waste iron, and extracts gold out of the waste from stamp mills. Electrolysis is also widely used to refine such metals as aluminum, gold, silver, and copper. Chlorine, which is used to purify water and as a bleach, is manufactured by electrolysis.

Electrolysis can be harmful if it occurs accidentally in nature. This has occurred where streetcar tracks were used as part of the electrical circuit, and other pipes lay beside the car line.

GEORGE L. BUSH

Related Articles in WORLD BOOK include:

Anodizing
Arrhenius, Svante A.
Electric Current
Electricity
Electrochemistry
Electrode
Electrolyte
Electroplating
Faraday, Michael
Ionization
Metallurgy

ELECTROLYTE, *ee LEK troh lite,* is a chemical compound that conducts electricity when it is dissolved or melted. The compound and the liquid together may be called the *electrolyte*. A substance which does not conduct electricity in a solution is a *nonelectrolyte*.

The most important electrolytes are water solutions of salts, acids, and alkalies. All the electrolytes make up one of the two main classes of electrical conductors. The other group is made up of metallic substances and a few nonmetallic materials. In this second group of conductors, the electric current is caused by the movement of negative particles of electricity, or *electrons*. The current in an electrolyte is carried by electrified atoms, or groups of atoms called *ions*. The effect which an electric current has on an electrolyte is the basis of electroplating and several other industrial processes. GEORGE L. BUSH

Related Articles in WORLD BOOK include:

Battery
Electric Current
Electrolysis
Electron
Electroplating
Ionization

ELECTROMAGNET, *ee LEK troh MAG net,* is a piece of metal wound with wire, which becomes magnetized when a current flows through the wire. When the current is shut off, the magnet loses its power. The electromagnet is the foundation of nearly all electrical machines, such as the electric motor and dynamo.

The electromagnet has two poles of magnetic material. Soft iron is almost always used. The iron poles are wound with insulated wire, which carries the current. William Sturgeon (1783-1850), an English electrician, discovered the principle of the electromagnet in 1825. Sturgeon's discovery gave science a magnet whose strength could be controlled absolutely by the strength of the current. PALMER H. CRAIG

See also ATTRACTION; CIRCUIT BREAKER; ELECTRIC CURRENT; ELECTROMAGNETISM.

ELECTROMAGNETIC THEORY OF LIGHT. See LIGHT (The Nature of Light).

ELECTROMAGNETIC WAVES. See LIGHT (Electromagnetic Waves; color picture, Uses of Electromagnetic Waves).

ELECTROMAGNETISM is magnetism which is produced by an electric current. The word also means the branch of physical science which studies the relations between electricity and magnetism. There are two basic principles of electromagnetism. (1) Electricity in motion produces a magnetic field; (2) A magnetic field in motion across an electrical field produces an electromotive force.

The first principle can be proved by placing a magnetic compass near a wire through which a current is passing. The compass needle tends to place itself at right angles to the wire. If a number of magnetic compasses are placed around the wire, the compass needles fall into the outline of a circle. They merely follow the lines of magnetic force, which are circles. See MAGNET AND MAGNETISM.

If the direction of the current is reversed, the needles will turn and point in the opposite direction. Reversing the current reverses the direction of the force, and proves that the motion of electricity causes magnetism. A coil with an electric current flowing through it acts like a magnet. It has a north and a south magnetic pole, like a bar magnet. The magnetism is increased when an iron rod, or *core*, is placed inside the coil. But is has the power or magnetism only while the current passes through it. If the direction of the current is changed, the poles reverse positions. A direct current of constant strength produces an unchanging magnetic field (see ELECTROMAGNET). An alternating current makes the magnetic field reverse itself every time the current reverses.

If a second coil is put next to the magnetized coil, the magnetic field passes through the second coil, and reverses every time the current in the first coil is reversed. An electromotive force is produced in the second coil due to the changing magnetic field in the coil. This is proof of the second principle of electromagnetism. If a magnetic compass is placed in an alternating-current coil, the needle is jerked back and forth. But it does not turn as rapidly as the current changes and the needle gradually loses its magnetism.

André Marie Ampère, the French scientist, discovered the laws of electromagnetism in 1826. The American physicist, Joseph Henry, made fundamental discoveries in electromagnetism. PALMER H. CRAIG

Related Articles in WORLD BOOK include:

Ampère, André Marie
Electric Motor
Electricity (Basic Principles)
Henry, Joseph
Light (color picture)
Magneto
Maxwell, James Clerk
Oersted, Hans Christian

ELECTROMETALLURGY. See ELECTROCHEMISTRY.

ELECTROMOTIVE FORCE is the force which tends to cause a flow of electricity. It may be compared to the pressure which causes water to flow through a pipe. Greater water pressure causes a greater number of gallons per minute to flow through a pipe. In a similar way a greater electromotive force (E.M.F.) causes a greater quantity of electricity per second, or greater current, to flow through an electric circuit. PALMER H. CRAIG

See also ELECTRIC CURRENT; ELECTRIC GENERATOR (Basic Principles); ELECTROMOTIVE SERIES; VOLT.

ELECTROMOTIVE SERIES, also called *Electrochemical Series,* is an arrangement of elements, usually metals, which is determined by the readiness of each element to give away electrons and so become positively charged. The order in which some common elements appear in the series is: potassium, barium, sodium, calcium, magnesium, aluminum, zinc, chromium, iron, nickel, tin, lead, hydrogen, copper, bismuth, mercury, and silver.

Any metal will replace any other metal *below* it in the series. For example, iron in copper sulfate solution produces iron sulfate and free copper, because iron replaces copper (which is below iron) in the solution.

Hydrogen is included in the electromotive series because it forms a positively charged ion, even though it is not a metal. Metals above hydrogen in the series will replace it from chemical compounds, and metals below hydrogen will not react with compounds that contain it.

In metallic electrodes for batteries, the farther apart in the series the metals are, the greater the electromotive force of the voltaic cell. PALMER H. CRAIG

See also ELECTROMOTIVE FORCE; VOLT.

ELECTRON, *ee LEK trahn,* a negative charge of electricity, is the smallest known unit of electrical charge. It has only $\frac{1}{1,840}$ the weight of a hydrogen atom. The electron is a powerful servant for mankind. The electric current used in homes and in industry consists of a flow of electrons through a copper wire, the conductor. A house lamp with one half ampere of electrical current flowing in it has three billion billion electrons passing through it every second.

Electrons are one of the fundamental building stones of the world. The atoms of all elements contain them. For example, an atom of hydrogen, the lightest kind of atom known, consists of one electron and a positively charged *proton* (see Proton). The proton is at the *nucleus*, or core, of the atom, and the electron is somewhere nearby. The negative charge of the electron and the positive charge of the proton balance each other. Each chemical element has its own special number of protons in its nucleus, and an equal number of electrons to balance the charge. The number of protons in the nucleus is the *atomic number* of an element. For the atomic number of each element, see Element, Chemical (table, Periodic Chart of the Elements).

In 1897, the British physicist Sir Joseph J. Thomson discovered that electrons carry electrical current. He found that they have a negative charge. In 1907, the American physicist Robert A. Millikan measured this charge. Physicists pictured electrons as tiny particles until 1927. In that year, the American physicist Clinton J. Davisson and the British physicist George Thomson independently discovered that electrons sometimes behave like waves. This makes it difficult to visualize their motion inside atoms. Scientists can only roughly say where they are and how they move. George Thomson

See also Atom; Electronics; Millikan, Robert A.; Television (How the Television Camera Works); Thomson, Sir Joseph J.

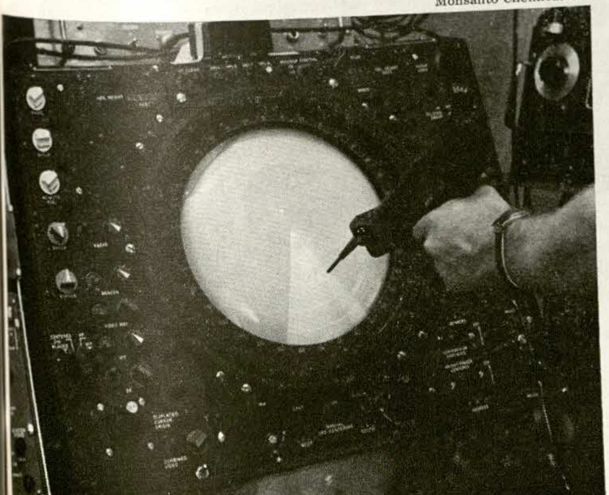
ELECTRON GUN is the heart of many electronic devices. These include television tubes, oscilloscope tubes, electron microscopes, and X-ray machines. In a television tube, an electron gun produces a pencil-sharp electron beam. This beam "writes" the picture on the phosphorescent screen in much the same way that a pencil writes on a sheet of paper. The higher the velocity of the electrons, the brighter the image. In one type of television receiver, the electron gun writes several hundred horizontal lines for each picture. The gun writes each line in a sixty-millionth of a second.

An electron gun consists of several basic building blocks. A *cathode* serves as the source of the electrons. A *control grid* next to the cathode *modulates*, or controls, the intensity of the electron stream. Beyond the control grid, an *electron optical lens* focuses the highly accelerated electrons into a tiny spot. A *deflection system* needed to do the writing moves the beam over the whole area of the screen. The *spot*, or the trace of the beam on the screen of the tube, is the image of the *crossover*, the narrowest section of the beam. Paul H. Gleichauf

See also Television (pictures, How the Television Camera Works; How the Television Receiver Works).

An Electron Gun "writes" on a radar screen used to control air traffic. Electrons light up the screen and identify aircraft.

Monsanto Chemical Co.



ELECTRON MICROSCOPE is a microscope that uses streams of electrons instead of light rays to magnify objects. The most powerful lens microscope can magnify an object only about 2,500 times its own diameter. The electron microscope magnifies about 25,000 times, or 10 times as much as an ordinary microscope. This image can also be photographed and magnified to approximately 100,000 times the original diameter, or 40 times as much as a regular microscope magnifies.

Uses. The electron microscope is one of the most important inventions of modern physics. It enables scientists to learn things about the internal structure of crystals, metals, and other matter that otherwise might never be known. It shows that many microbes have smaller microbes living on them as parasites. It also shows what happens to microbes attacked by drugs.

Principle of the Electron Microscope. In a powerful light microscope, a thin slice of an object such as an insect is put on a slide just beneath the lens. Under the slide is a mirror that reflects light through and around the insect. The lens focuses the light rays so they can be seen. Light is absorbed by the insect at some points. At other points, the light passes through the insect and gives it a transparent appearance. Other parts may absorb all but the red light, and these parts appear red. Light rays are clear when focused from objects so small that magnifying them 2,500 times will make them visible. But light waves are too long to give a clear picture of something smaller, such as a virus. The picture becomes blurred. A shorter wave length is needed to show more clearly the shape and mass of the virus. Streams of electrons are the answer, since they have very short wave lengths.

The mirror and light underneath the slide are replaced in the electron microscope by an electron gun that shoots beams of electrons toward the object (see Electron Gun). The slides are about two millionths of an inch thick, so the electrons can get through. The "lens" in an electron microscope is not made of glass, as is the lens in the optical type of microscope. The electron microscope's lens is merely an opening with no obstruction at all, with magnets or electrostatic fields put around the opening to bend the streams of electrons and focus them. They cast an image on a film, or screen, farther along in the microscope. The scientist looks through a hole in the side of the microscope to see the image on the screen which is formed by the electrons. This image can be photographed on regular photographic film. Palmer H. Craig and Robley C. Williams

See also Cathode Rays; Electron; Microscope.

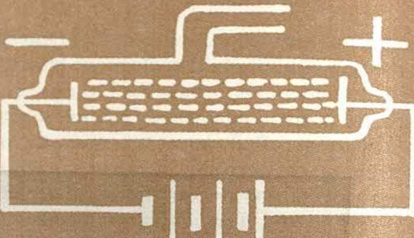
ELECTRONE. See Organ (Electronic Organ).

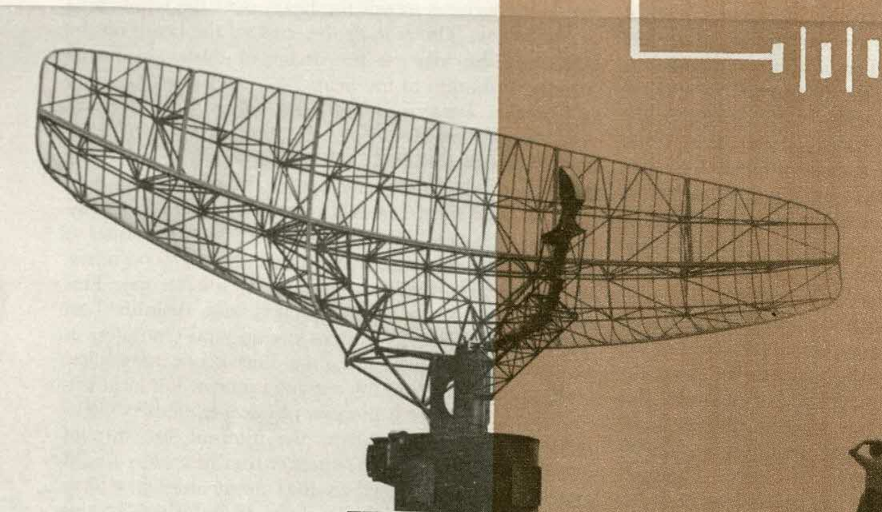
ELECTRONIC BRAIN. See Computer; Guided Missile.

ELECTRONIC FLASH LAMP. See Flash Lamp.

ELECTRONICS

The Crookes Tube, *right,* was the "grandfather" of electronic tubes.





Raytheon Manufacturing Co.

Radar, *above,* provides man with powerful electronic "eyes" capable of seeing many miles through fog and darkness.

Medicine Uses Electronics in many ways. Television, *right,* can show many doctors how to perform a difficult operation.

In Industry, electronic devices may be used to control the current used in welding, *right,* and in many other ways.

Ryan Aeronautical Co; NBC

Diode

Electronic "Brains," *below,* can run the machines in a factory and solve complex business and scientific problems.

Remington Rand

Transistor

U.S. Air Force

Electron Microscopes reveal objects invisible to the eye with ordinary microscopes.

Triode

Television has supplied the field of communications with "eyes" as well as a "voice" to provide news and entertainment for large audiences.

NBC

Zenith Radio Corp.

Miniature Radios have been made possible by the development of electronic devices such as transistors and tiny diodes and triodes.

ELECTRONICS, *ee* LEHK *TRAHN icks,* is a branch of the science of electricity. It has made possible such modern wonders as television, radio, radar, and giant computers. Electronics takes its name from *electrons,* the tiny, negatively charged particles of atoms. It deals chiefly with the *flow of electrons* (or electric current) passing through vacuum tubes, gas-filled tubes, transistors, and other devices. Without these electronic devices, television, radio, radar, and electronic computers could not work. Electric fans, electric generators, and electric motors are *not* electronic, because they depend only on electrons flowing through wires.

Most of electronics consists of the science of using tubes, transistors, and other electronic devices to control small electric *signals.* These signals may represent sounds, such as the ones brought to you by radio. They may make up the pictures you see on television. In electronic computers, the signals may represent numbers used to solve problems for scientists and businessmen. These signals make it possible for electronic devices to control huge machines and to aim guided missiles. They give motion pictures their voice. The electron microscopes that help scientists see tiny germs are electronic devices. So are flashing neon advertising signs, and fluorescent lamps that light homes and offices.

The first practical use of electronics came with the discovery of electrons and X rays in the 1890's. Then came the use of electronic tubes in radios. By the late 1950's, electronics had become the fifth largest manufacturing industry in the United States. It had nearly $12,000,000,000 in sales each year and employed about 1,500,000 workers.

Importance of Electronics

In Industry, electronic devices operate atomic reactors. They regulate the current used in spot welding, and control the speed of lathes and other machines driven by electric motors. Electronic thermostats adjust the temperature of ovens. In steel mills, electronic devices measure and control the thickness of steel plates.

Food processors use photoelectric cells, or "electric eyes," to sort fruit and other products according to size and color. Other electronic devices produce radio waves used to melt metals, and to heat waterproof plastic cement used to glue plywood together. Some electronic devices detect gas leaks. Teletypewriters and facsimile machines are electronic communication devices. Businessmen use electronic computers to do their bookkeeping. Electronics has made *automation* possible in some industries. See Automation.

In the Home, electronics makes possible radio, television, and telephones. When you telephone someone in a distant city, your voice becomes weaker the farther it travels. Long-distance telephone lines have electronic tubes that *amplify,* or strengthen, your voice thousands of times. Microwave radio transmitters may relay your voice from hilltop to hilltop. Your voice may travel to Europe by an undersea cable that has more than a hundred electronic amplifiers.

Many persons build and install high-fidelity music systems in their homes. These systems include radios, record players, and tape recorders. All of them work by electronic tubes and transistors. Many families have electronic organs in their homes. Electronic thermostats control the temperature in some homes, and photoelectric cells open the garage door when the family car enters the driveway.

In National Defense, radar detects airplanes flying hundreds of miles away. It helps aim guns and guide missiles to planes, ships, and other targets. When the shells or missiles approach the target, an electronic *proximity fuse* explodes them. Some missiles are guided by electronic devices that detect infrared rays given off by the target (see Infrared Rays).

Military airplanes carry radios, radar, bombsights, and many other electronic devices. These provide communication with the ground and with other planes. They help pilots control and navigate planes, and aim bombs and missiles. Ships and submarines also have radar and other electronic equipment. Sonar, for example, is an electronic device that detects ships and submarines by means of underwater sound waves.

In Science, astronomers use electronic devices to control telescopes and to photograph stars and measure their light. They study radio waves from stars with radio telescopes. Biologists use electron microscopes to study viruses and other organisms too small to be seen with ordinary microscopes. Physicists use electronic atom smashers to study the nuclei of atoms. Geiger counters aid physicists in detecting atomic radiations, and mass spectrographs help them identify atoms and molecules (see Mass Spectroscopy). Electronic computers solve complex scientific problems.

Doctors photograph the inside of the body and attack cancer with X rays produced by electronic tubes. They treat other ailments with electric currents produced by diathermy machines. Electrocardiographs help physicians detect and study heart diseases. Electroencephalographs record the tiny currents produced by the

TERMS USED IN ELECTRONICS

Amplifier is an electronic device that puts out a strong signal when it is fed a weak signal.

Anode is an electrode of an electron tube. It is made positive to speed up or to collect electrons given off by a cathode.

Cathode is a negative electrode of an electron tube. It gives off electrons when it is heated, or when it is struck by light, ions, or other electrons.

Electric Current is a flow of electrons or ions.

Electrode gives off, collects, or controls the movement of electrons or ions.

Electron is a negatively charged part of an atom.

Frequency is the number of times a second that an electric signal changes back and forth from positive to negative.

Grid is an electrode used to control the flow of electrons between a cathode and an anode.

Ion is an atom or molecule that has become electrically charged by gaining or losing one or more electrons.

Ionize means to add electrons to or remove them from an atom or a molecule.

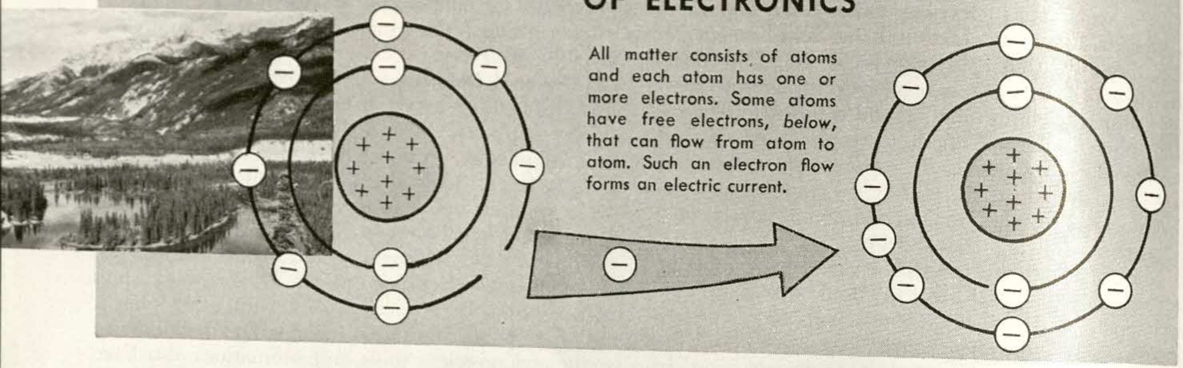
Noise is a current or voltage that interferes with a signal.

Oscillator is an electronic device that produces an electric signal of a certain frequency. An amplifier can be used as an oscillator. Part of the signal put out by the amplifier is fed back into it. This produces signals that *oscillate,* or vibrate, at a certain frequency.

Rectifier is an electronic device that can change alternating current to direct current.

Signal is an electric current or voltage.

BASIC PRINCIPLES OF ELECTRONICS



All matter consists of atoms and each atom has one or more electrons. Some atoms have free electrons, *below,* that can flow from atom to atom. Such an electron flow forms an electric current.

brain. Electronic hearing aids make it possible for many partially deaf persons to hear.

Basic Principles of Electronics

Electronics deals with flowing electrons. When electrons flow, they form an electric current and can be put to work. But, in order to flow, electrons must be free to move. To understand electronics, you must know something about (1) the nature of matter, (2) how electrons escape from atoms, (3) how electronics makes electrons flow, and (4) how electronics controls an electron flow.

The Nature of Matter. All matter consists of atoms, and each atom contains one or more electrons (see Atom). The atoms of some kinds of matter, called *conductors,* have *free electrons.* Free electrons can flow from atom to atom. Such a flow is an electric current. All metals have free electrons, usually one for each atom, so metals are conductors of electricity.

Ions form part of an electric current in gases and liquids that conduct electricity. An ion is an atom or molecule that has become electrically charged by gaining or losing one or more electrons.

In some materials, called *insulators* or *dielectrics,* the electrons are bound tightly to their atoms. Few are free to move from atom to atom. Glass and rubber are examples of these *nonconductor* materials.

How Electrons Escape from Atoms. Electrons escape from atoms in three ways: (1) by thermionic emission, (2) by secondary emission, and (3) by photoemission.

Thermionic Emission is the freeing of electrons by heat. Ordinarily, electrons cannot escape from the solid substances of which they form a part. However, the free electrons in a conductor or semiconductor are always in motion. If a metal is heated, the electrons move faster. At a high temperature, some electrons move fast enough to escape from the substance.

Secondary Emission is the freeing of electrons by bombarding them with other electrons or ions.

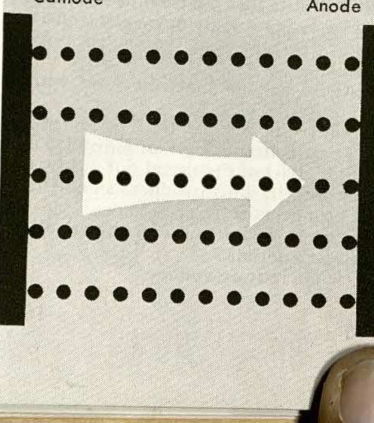
Photoemission is the freeing of electrons by light. The atoms of some substances give off electrons when light strikes them.

How Electronics Makes Electrons Flow. All electrons are negatively charged. If electrons escape from metal atoms, they are attracted by an *anode* (an electrode made positive) and forced away from a *cathode* (a negative electrode). A flow of electrons from a cathode to an anode is an electric current.

How Electronics Controls an Electron Flow. Electrons flowing in solids, liquids, or gases bump into the atoms or molecules of these substances. This makes the electrons bounce around and slows their motion. But electrons released in a vacuum move freely and tend to travel in a straight line like a ball thrown in the air.

Magnetic and electric fields can control a flow of electrons. A *magnetic field* surrounds every magnet. Electric currents also produce magnetic fields. Electric charges produce an *electric field.* A magnetic field can deflect electrons. An electric field not only deflects electrons, but it can also make them move nearly as fast as the speed of light, if the field is strong enough. Elec-

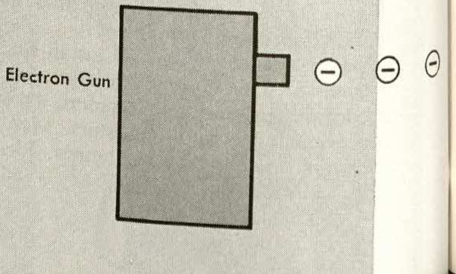
MAKING ELECTRONS FLOW



All electrons are negatively charged. Therefore, they are forced away from a *cathode,* a negative electrode, *left,* and will flow toward an anode, an electrode made positive.

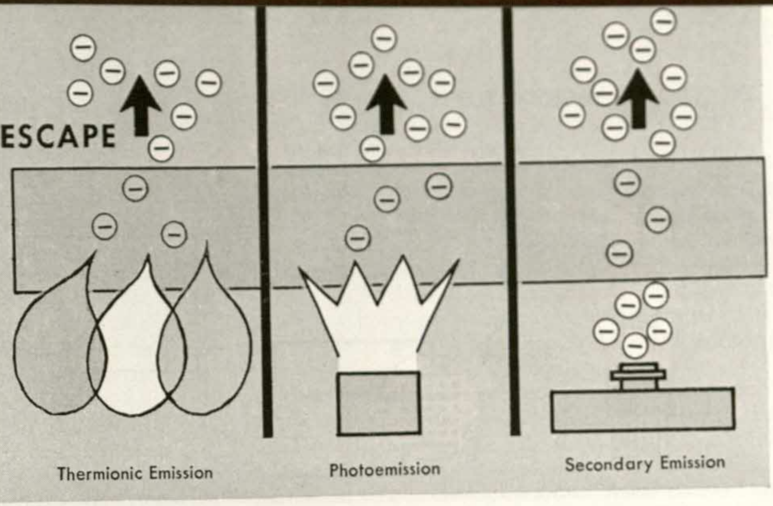
CONTROLLING AN ELECTRON FLOW

Electronics controls a flow of electrons or ions in two ways. These are, *right,* by magnetic fields or by electric fields.



HOW ELECTRONS ESCAPE FROM ATOMS

Electrons escape from atoms in three ways. These are by *thermionic emission*, or heat; by *photoemission*, or light; and by *secondary emission*, or by bombarding the electrons with other electrons or ions.



trons strike the screen of a television picture tube at one tenth the speed of light. See Electric Field; Magnet and Magnetism (Polarity of Magnets).

Electronics at Work. Electronics puts these principles to work by means of (1) vacuum tubes and (2) gas-filled tubes. Some of these principles are also important in solid state devices, such as transistors. These devices perform many of the same functions as vacuum tubes and gas-filled tubes, but they work in a somewhat different way (see Solid State Physics).

Vacuum Tubes

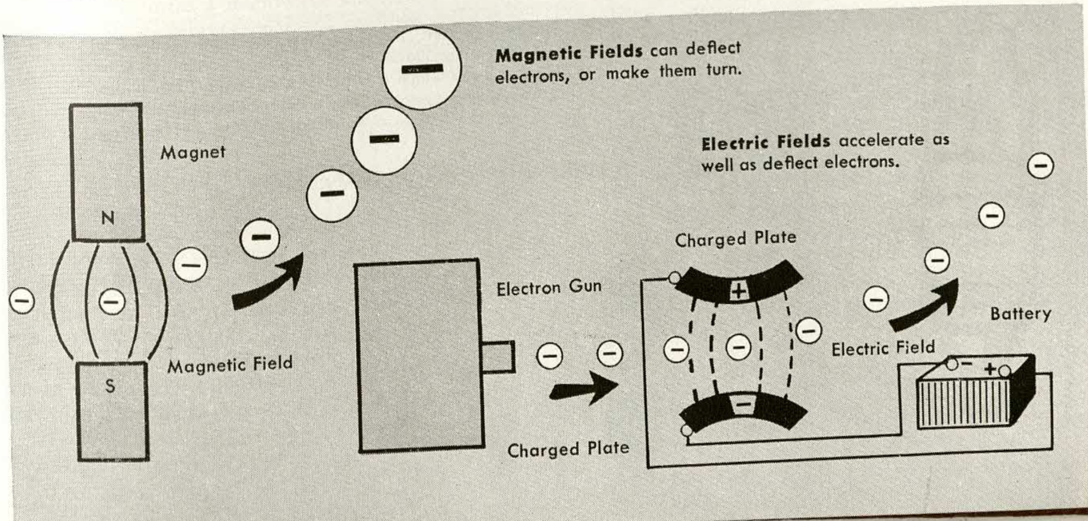
A vacuum tube is a metal or glass tube from which almost all the air has been removed so that air atoms and molecules will not interfere with the electron flow. Vacuum tubes amplify and rectify electric currents in electronic devices, and produce signals by oscillation. The chief kinds of vacuum tubes include (1) diodes, (2) triodes, (3) multielectrode tubes, (4) electron-beam tubes, (5) microwave tubes, (6) particle accelerators, and (7) photoelectric cells.

Diode is the simplest kind of vacuum tube. Radio and television sets use diodes to change the alternating current from a wall socket to the direct current needed to produce sound and pictures. They also use diodes to change the electromagnetic waves, or signals, sent out by radio and television broadcasting stations into signals that can be heard or seen. See Radio (Vacuum Tubes; color diagram, How Radio Works).

A diode contains two electrodes: (1) a *hot*, or *thermionic*, *cathode* that supplies electrons by thermionic emission, and (2) a cold *plate*, or *anode*, that attracts and collects the electrons. Some thermionic cathodes are made of a tungsten-thorium wire similar to the filament in a light bulb (see Electric Light). The wire becomes hot when an electric current passes through it. The hot wire releases electrons. But most thermionic cathodes are tiny tubes coated with a mixture of barium oxide and strontium oxide. These compounds give off electrons at lower temperatures than a pure metal. An electric current heats a coil of wire inside the cathode. This heat makes the coating give off electrons. The anode, usually a somewhat larger tube made of nickel, surrounds the cathode.

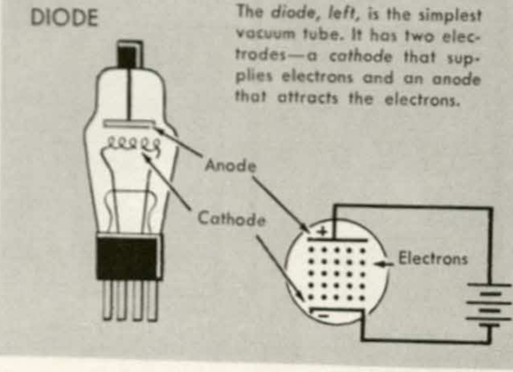
Electrons flow from the cathode to the anode only when the voltage applied to the anode is positive, so that the anode has a positive charge. Electrons will not flow if the anode is negatively charged. Alternating current constantly reverses direction as it flows through a wire. Each time the current reverses direction, it alternately carries electrons to the anode, making it negative, and away from the anode, making it positive. The anode attracts electrons from the cathode only during the periods when it is positive. In this way, a diode changes alternating current, which flows in two directions, into a pulsating direct current, which flows in only one direction.

The signals sent out by radio and television stations also switch back and forth from positive to negative, just as an alternating current does. When these signals

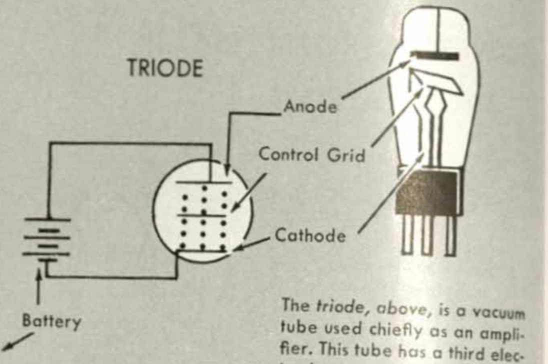

Magnetic Fields can deflect electrons, or make them turn.

Electric Fields accelerate as well as deflect electrons.

ELECTRONIC VACUUM TUBES



The *diode, left,* is the simplest vacuum tube. It has two electrodes—a *cathode* that supplies electrons and an *anode* that attracts the electrons.



The *triode, above,* is a vacuum tube used chiefly as an amplifier. This tube has a third electrode—a *control grid* that helps control the electron flow.

are amplified and fed to the anode of a diode tube, electrons will flow from the cathode only when the incoming signals are positive. In this way, the diode produces an electric current that varies just as the signals do. This current can then be amplified and changed into sound by a speaker.

Triode is a kind of vacuum tube used chiefly as an amplifier. Radio and television stations use triodes to amplify the signals they send out. These signals become weaker and weaker as they travel farther from the stations. Because of this, radio and TV sets have triodes or other types of tubes to amplify these signals when their antennas pick them up.

A triode works exactly like a diode, except that it has a third electrode called a *control grid* between the cathode and anode. This grid is usually a screen or coil of fine wire. It regulates the flow of electrons, much as a Venetian blind controls the amount of light that enters a room. The less negative the grid, the greater the number of electrons that the positive anode pulls through the grid openings. The more negative the grid, the fewer the number of electrons that flow. Small changes in the voltage of the grid produce large changes in the electron flow through the tube. For example, the weak signals picked up by a radio antenna go to the grid of a triode or other similar tube. The weak signal changes the charge and voltage on the grid, and so produces big changes in the number of electrons flowing through the triode. In this way, the triode amplifies incoming signals. A diode then rectifies the amplified signals into a pulsating direct current that can be used to produce sounds.

Multielectrode Tubes are vacuum tubes with four or more electrodes. The *tetrode* is an amplifying tube used in radio and television sets. It has a fourth electrode called the *screen grid* between the control grid and the anode. This grid has a positive electrical charge so it will draw a steady flow of electrons from the cathode. When an incoming signal is amplified, it sets up an electric field at the anode. If this field reached the grid, it would change the grid's voltage somewhat. This would make the amplifier oscillate. The screen grid acts as a shield to prevent this from happening.

The *pentode* is the most commonly used amplifying tube in radio and television receivers. A pentode has a fifth electrode called a *suppressor grid* between the screen grid and the anode. Electrons flowing from the cathode to the anode cause the anode to give off electrons by secondary emission. These *secondary electrons* can interfere with the operation of the tube. The suppressor grid has a negative charge that keeps these electrons from leaving the anode.

Some tubes have six or more grids. These tubes are used chiefly in radio receivers to change the frequency of an incoming signal to another frequency at which it can be more easily amplified.

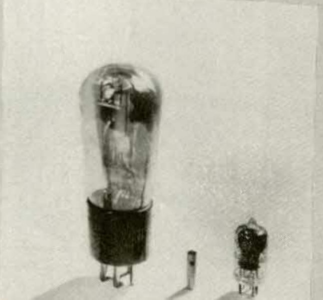
Electron-Beam Tubes include electron microscopes, oscilloscopes, and television picture tubes. In an electron-beam tube, an *electron gun* forms the electron beam. This gun consists of an anode with a hole in it placed in

TETRODE

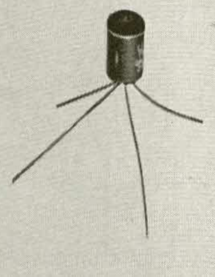
General Electric

The tetrode, *left*, is a four-electrode tube used as an amplifier or oscillator by television transmitting stations. It is enclosed within a water-cooling jacket. The photograph, *below*, compares two ordinary vacuum tubes with a transistor. A typical transistor is shown, *right below*.

Bell Telephone Laboratories



TRANSISTOR



front of a small, round cathode. Electrons attracted toward the anode go through this hole and travel as an *electron beam* through a vacuum beyond the anode. Electric or magnetic fields around the beam act as electron lenses. These fields control the size of the beam, or focus it, much as glass lenses focus beams of light.

In an *electron microscope*, a beam of electrons passes through the subject to be examined. Electron lenses project the electrons on a fluorescent screen or a photographic plate. This gives a greatly magnified picture of the subject (see ELECTRON MICROSCOPE). In an *oscilloscope tube*, an electron beam focuses in a pin-point spot on a fluorescent screen like that on the face of a television picture tube. Electric or magnetic fields deflect the electron beam. This causes the bright spot to move from side to side and up and down over the fluorescent screen. Scientists, engineers, and radio and TV repairmen use oscilloscopes to show variations in electric currents and voltages (see OSCILLOSCOPE). In a television picture tube, the electron beam traces out a picture (see TELEVISION [Kinescope]). An X-ray tube is an electron-beam tube that aims a beam of electrons at a special anode. When the electrons strike the anode, it gives off X rays. See X RAYS (How X Rays Are Produced).

Microwave Tubes generate and amplify microwaves. Microwaves are radio waves that change from positive to negative and back again billions of times a second. Radar depends on microwaves. So do long-distance telephone and television microwave-relay systems.

In a triode, the electrons travel slowly between the cathode and the control grid. The radio signal being fed into the control grid may change from positive to negative while an electron is traveling from the cathode to the anode. This makes the triode less effective as an amplifier at high frequencies. At microwave frequencies, tubes are used in which electrons travel in a beam at least one twentieth of the speed of light. These tubes include (1) klystrons, (2) traveling-wave tubes, and (3) magnetrons.

Klystrons make use of an electron beam. The beam first flows through a hollow metal box called a *resonator*. The microwave signal to be amplified is also fed into the resonator. This signal produces a microwave electric field that alternately slows down and speeds up the electrons in the beam billions of times a second as the electrons pass through the resonator. After the electrons leave the resonator, the faster ones catch up with the slower ones, so that the electrons become bunched together. This forms a microwave alternating current. This alternating-current electron beam flows through a second resonator, where it produces a microwave electric field. This in turn produces a microwave signal in a circuit connected to the second resonator. Klystrons can produce pulses of microwaves tens of millions of watts in power.

Traveling-Wave Tubes also use an electron beam and work somewhat like a klystron. However, the electron beam flows through a coil of wire called a *helix* instead of through a resonator. The microwave signal to be amplified is applied to this wire. The signal travels along the wire at the same speed as the electrons in the beam. The electric field produced by the signal in the wire interacts with the electrons in the beam to make the signal stronger. These tubes amplify microwaves up to frequencies of 50,000,000,000 vibrations a second.

Magnetrons consist mainly of a diode with a cylindrical cathode inside a cylindrical anode. Slots cut in the anode act as *resonant cavities*. A strong magnetic field bends the paths of the electrons as they leave the cathode so that they sweep in spirals past the resonant cavities. These cavities have microwave electric fields that act on the electrons somewhat as the electric fields do in the resonators used by klystrons. Magnetrons are used chiefly as oscillators in radar equipment.

Particle Accelerators produce extremely high-energy beams of electrons or ions. Physicists use these beams to smash the nuclei of atoms. This helps them learn more about the composition of atoms. Particle accelerators include the betatron, cyclotron, linear accelerator, and synchrotron. These devices increase the speed of the electrons or ions by various means. In the linear accelerator, for example, vibrating radio waves accelerate the electrons or ions repeatedly at various points along their paths of travel. Such a device can give electrons as much energy as they would gain by being accelerated by a billion volts of electricity, ten million times the voltage of the electricity used in most homes. See ATOM SMASHER.

Photoelectric Cells are tubes used to measure color, to sort objects, and to transmit letters and drawings electronically. In these tubes, light falling on a sensitive cathode knocks electrons out of the cathode. These electrons flow to the anode. The stronger the light, the greater the electron flow. See ELECTRIC EYE.

Gas-Filled Tubes

Gas-filled tubes contain small amounts of various kinds of gases. These tubes can produce light, change alternating current to direct current, and control machinery. Common types of gas-filled tubes include (1) neon signs and fluorescent lights, (2) thyratrons, and (3) mercury-pool rectifiers.

Electric Signs and Fluorescent Lights have an electrode at each end. In a neon tube, electrons flowing from one electrode to the other strike gas atoms in the tube. The gas atoms absorb energy from the electrons, and *radiate*, or release, this energy as light of a particular color. Neon gas produces red light. The addition of mercury vapor produces blue-green light. Fluorescent lights work somewhat like neon signs, except that they use argon gas and mercury vapor. They also have a fluorescent coating on the wall of the tube. See FLUORESCENT LAMP; NEON.

Thyratrons are tubes filled with mercury vapor. A thyratron has a cathode, anode, and control grid just as a triode does. In a vacuum triode, the electrons repel one another, because they are all negative. This limits the number of electrons that can travel between the cathode and anode at one time. In a thyratron, the electrons turn mercury atoms into positive ions by knocking electrons loose from the mercury atoms. These positive ions counteract the repulsion between the negative electrons, and allow more electrons to be present in the tube at one time. In a thyratron, a weak flow of electrons to the grid can control a current thousands of times stronger.

Factories use thyratrons to control the current in welding machines and electric motors that run lathes and other machine tools. Thyratrons can also be used as rectifiers.

Mercury-Pool Rectifiers are used when currents as large as 1,000 amperes must be rectified. Electroplating plants, aluminum plants, and other factories that use large amounts of current have mercury-pool rectifiers to change alternating current to direct current.

A mercury-pool rectifier has a metal container with a pool of mercury at the bottom and an insulated anode sealed inside at the top. A small mercury-pool rectifier may be about the size of a large tin can. A large one may stand 9 feet high and include water-cooling coils. In these rectifiers, the cathode is a little bright spot that the current makes on the surface of the mercury. The current ionizes the vapor from the mercury and electrons flow to the anode. An *ignitron* is a mercury-pool rectifier in which the ionization process is started by applying a voltage to a rod made of a poor conducting material. The rod dips into the mercury and "ignites" the rectifier.

Solid State Devices

Solid state devices developed from studies in solid state physics. *Semiconductor* devices make up one important class of solid state devices. The power used to heat the cathode of a vacuum tube is often very large compared with the power of the current it amplifies or produces. Semiconductor solid state devices are made of the crystals of such semiconductors as silicon and germanium. They perform many of the functions of vacuum tubes, but they use much less power and work on somewhat different principles. Such solid state devices can be built much smaller and more compactly than vacuum and gas-filled tubes. They also last longer. Common semiconductor devices include transistors, solar batteries, and Esaki, or tunnel, diodes. See SEMICONDUCTOR; TRANSISTOR; SOLAR ENERGY (Solar Batteries).

There are also many kinds of *nonsemiconductor* solid state devices. One of the most important of these devices is the *maser*. Masers are used to generate and amplify microwave radio signals. Their operation depends on the fact that certain materials can absorb and emit microwaves of particular frequencies. In *ammonia masers*, ammonia gas is made to emit tiny microwaves having a frequency of about 24,000,000,000 vibrations a second. This maser can act as a precise electronic clock. *Solid state masers* have a material such as synthetic ruby surrounded by a magnetic field. The ruby acts somewhat as the ammonia does in an ammonia maser. It can take a microwave signal of one frequency and add to this the power of microwaves of another frequency. In so doing, the maser amplifies the signal. Other kinds of nonsemiconductor solid state devices include cryotrons and magnetic cores used in computers. See COMPUTER (Parts of a Computer); CRYOTRON.

History

Early Experiments. Electronics developed from experiments made in the 1800's with electric currents flowing through glass tubes. Among the first men to make such experiments was Heinrich Geissler (1814-1879), a German manufacturer of scientific instruments. Geissler removed most of the air from a glass tube. He

HISTORY OF ELECTRONICS

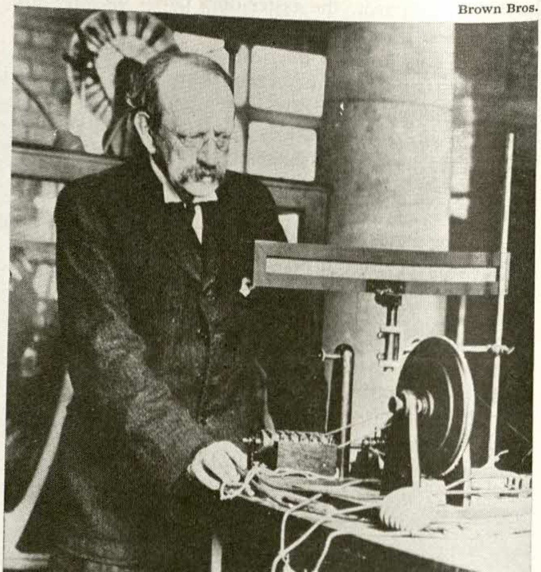
Brown Bros.

Sir William Crookes, *above,* a British scientist, invented the Crookes vacuum tube. His experiments, beginning about 1878, showed that a current flowing through such a tube consisted of particles.

Brown Bros.

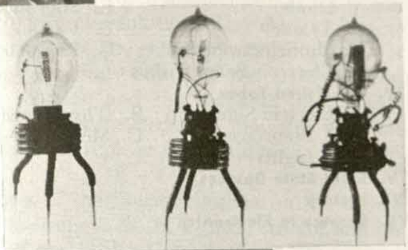
Discovery of the Electron and X Rays in the 1890's marked the real beginning of electronics. Wilhelm K. Roentgen, *above right,* a German physicist, discovered X rays in 1895. An early X-ray machine is shown *above.* Later in the 1890's, British physicist Joseph J. Thomson, *below,* measured some of the properties of the particles that make up a current in a vacuum tube.

Brown Bros.



The Fleming Valves, *below,* were early thermionic radio diode tubes. John A. Fleming, *left,* a British scientist, invented these tubes in 1904.

Brown Bros.



Institute of Radio Engineers

Progress in Electronics depended on the development of an amplifier. American scientist Lee De Forest, *above,* invented the *audion,* a triode amplifying tube, in 1907. In the 1920's, American scientist Vladimir K. Zworykin, *below,* developed both a TV camera tube, *left,* and a TV picture tube, *right.*

RCA

found that the tube would glow with colors when an electric current flowed through it. See GEISSLER TUBE.

About 1878, Sir William Crookes, a British scientist, began to experiment with tubes similar to Geissler tubes. Crookes discovered that obstacles placed in such tubes cast shadows on the sides of the tubes when a current flowed through them. This indicated that the current consisted of particles. He also showed that a magnetic field affects the operation of these tubes. See CROOKES TUBE.

In the 1800's, Thomas A. Edison began experimenting with the carbon-filament light bulb he had invented. Edison inserted a small metal plate in the bulb, and learned that a current would flow from the filament to the plate if the plate were positively charged. The bulb also glowed with a blue light. This transmission of current from the filament to the plate became known as the *Edison effect.* Actually, Edison had invented the thermionic diode. He patented his device, but failed to make any use of it, and the patent lapsed.

The Electron and X Rays, discovered in the 1890's, marked the real beginning of electronics. Wilhelm K. Roentgen, a German physicist, discovered X rays in 1895. That same year, the French scientist Jean B. Perrin showed that current flowing through a vacuum tube consists of negatively charged particles. The British physicist Joseph J. Thomson measured some of the properties of these particles, later named electrons, in a series of experiments between 1895 and 1897. In 1909, Robert A. Millikan, an American physicist, accurately measured the charge of the electron. These developments meant that scientists could now build devices to control and put to work the power of flowing electrons. In 1904, John A. Fleming, a British scientist, built a vacuum diode tube that could detect radio signals. The tube was called the *Fleming valve,* because it allowed current to pass through in only one direction.

The Electronic Age. For real progress in electronics, an amplifier was needed. In 1907, the American inventor Lee De Forest invented the *audion,* a triode vacuum tube. Between 1912 and 1914, Harold D. Arnold, an American physicist, and Irving Langmuir, an American chemist, greatly improved the triode by increasing the vacuum in the tube. In 1912-1913, De Forest and Edwin H. Armstrong, an electrical engineer, developed the triode as an oscillator. About 1914, engineers designed triodes for use in telephone lines. This development made transcontinental telephone systems possible. Walter Schottky, a young German physicist, invented the tetrode in 1916, and Benjamin D. H. Tellegen, a Dutch engineer, invented the pentode in 1926. These tubes greatly improved the radio. The iconoscope television camera and the kinescope television picture tube were developed in the 1920's by Vladimir K. Zworykin, an American research scientist.

World War II brought about many advances in electronics. In 1939, the British scientists John T. Randall and Henry A. H. Boot invented the magnetron. This tube made microwave radar possible. Also in 1939, two American scientists, Russell H. Varian and his brother Sigurd F. Varian, developed the klystron microwave tube. An Austrian-American scientist, Rudolph Kompfner, invented the traveling-wave tube in 1943. John W.

Mauchly and John P. Eckert, Jr., both of the United States, completed the first electronic computer in 1946.

Recent Developments. The crystal detectors used in the earliest radios were solid state devices. However, electronics entered a new era when the transistor was invented in 1948. Ten years later, the *Esaki diode* was invented. Scientists hoped it would perform certain electronic operations at frequencies higher than the operating frequencies of transistors. About 1960, scientists began to incorporate the functions of several different electronic components into single "blocks" of material. The development of these miniature systems was called *molectronics*, or *molecular electronics*.

Masers were developed in the United States in the 1950's. These devices can act as precise microwave oscillators or amplifiers. In 1961, an *optical maser*, also called a *laser*, was continuously operated for the first time. It is used to amplify light waves.

Careers in Electronics

The electronics industry includes firms that range in size from small radio-repair shops to giant manufacturing corporations. More than 4,200 companies manufacture electronic products in the United States. Some firms specialize in making only certain electronic parts, such as vacuum tubes or transistors. Others design complete communication, computer, and military electronic systems.

The electronics industry needs college-trained scientists and engineers, especially experts with doctor's degrees in physics or electrical engineering. Almost a fifth of the 500,000 engineers in the United States work in electronics. The industry also needs technicians with trade-school training in electronics.

Young people interested in electronics careers should take as many mathematics and science courses as possible in high school. They should continue their studies in mathematics, physics, and engineering at a university or college. The best professional and executive positions in electronics require such training. Almost all leading executives in electronics companies are either engineers or scientists. JOHN ROBINSON PIERCE

Related Articles in WORLD BOOK include:

BIOGRAPHIES

Armstrong, Edwin Howard
Bardeen, John
De Forest, Lee
Edison, Thomas Alva
Langmuir, Irving
Millikan, Robert Andrews
Roentgen, Wilhelm Konrad
Thomson, Sir Joseph John
Zworykin, Vladimir Kosma

ELECTRONIC DEVICES

For a list of electronic devices, see Electronics in the PHYSICS section of the READING AND STUDY GUIDE.

UNCLASSIFIED

Anode
Astronomy (Radio Astronomy)
Atom
Attraction
Automation
Business Machines (Punched-Card Machines)
Cathode
Cathode Rays
Diathermy
Electricity
Electrode
Electromagnet
Electromagnetism
Electron
Infrared Rays
Ionization
Light (Electromagnetic Waves)
Magnet and Magnetism
Matter
Microwave
Motion Picture (Sound)
Neon
Physics
Semiconductor
X Rays

Outline

I. Importance of Electronics
  A. In Industry
  B. In the Home
  C. In National Defense
  D. In Science
II. Basic Principles of Electronics
  A. The Nature of Matter
  B. How Electrons Escape from Atoms
  C. How Electronics Makes Electrons Flow
  D. How Electronics Controls an Electron Flow
  E. Electronics at Work
III. Vacuum Tubes
  A. Diode
  B. Triode
  C. Multielectrode Tubes
  D. Electron-Beam Tubes
  E. Microwave Tubes
  F. Particle Accelerators
  G. Photoelectric Cells
IV. Gas-Filled Tubes
  A. Electric Signs and Fluorescent Lights
  B. Thyratrons
  C. Mercury-Pool Rectifiers
V. Solid State Devices
VI. History
VII. Careers in Electronics

Questions

How does electronics differ from ordinary electricity?

What are the most commonly used tubes in radio and television sets?

What kind of electronic device can be used to sort fruit?

What kind of electronic tube did Thomas A. Edison invent?

About what fraction of the engineers in the United States work in the field of electronics?

How do magnetic and electric fields affect flowing electrons?

What is a grid? How is it used in electronic tubes?

What is a rectifier and what does it do?

How does a triode differ from a diode?

What is thermionic emission?

Books to Read

BENDICK, JEANNE. *Electronics for Young People*. 4th ed. McGraw, 1960. This introductory book discusses such aspects of electronics as automation, computers, and nuclear energy.

HERTZBERG, ROBERT. *Ham Radio Handbook*. Arco, 1959.

LEWELLEN, JOHN B. *Understanding Electronics: From Vacuum Tube to Thinking Machine*. Crowell, 1957. An explanation of basic concepts and theories.

MANDL, MATTHEW. *Fundamentals of Electronics*. Prentice-Hall, 1960. The theory and practical aspects of basic electronics are briefly discussed for readers with some background.

MORGAN, ALFRED P. *The Boys' First Book of Radio and Electronics*. Scribner, 1954. *The Boys' Second Book of Radio and Electronics*. 1957.

ROSS, FRANK X. *Automation: Servant to Man*. Lothrop, 1958. An explanation of the operation and uses of electronics in such things as computers and automatic factories.

STODDARD, EDWARD. *The Real Book of Electronics*. Garden City, 1956. Radio, television, and other aspects of electronics are simply treated for young readers.

UPTON, MONROE. *Electronics for Everyone: The Story of Electricity in Action*. 2nd rev. ed. Devin-Adair, 1959. Transistors, television, radio, radar, hi-fi, video tape, space electronics: what they are and how they work.

WELLS, ROBERT. *Messages, Men and Miles: Electronic Communications: How They Work*. Prentice-Hall, 1958. Beginning with a historical background, this explains the mechanics of electronic communication, outlines new developments, and forecasts things to come.

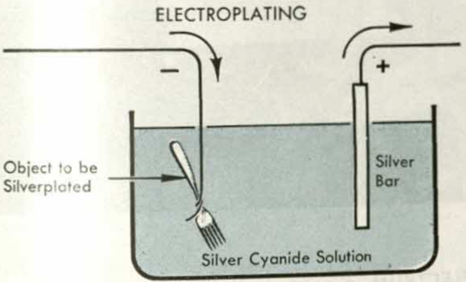
ZARCHY, HARRY. *Using Electronics: A Book of Things to Make*. Crowell, 1958. Includes directions and diagrams for making many electronic devices.

ELECTROPLATING, *ee LEK troh* PLAYT *ing*, is the process of putting a metallic coating on a metal or other conducting surface by using an electric current. It is done for appearance, for protection against corrosion, or to make plates for printing or other reproduction work.

The article to be plated is thoroughly cleaned of grease and dirt by dipping it in acid and alkaline cleaning solutions. It is then put in a solution of the metal with which it is to be coated, and connected to the negative end of a source of electricity. The positive electric terminal is connected to another conductor which is also dipped into the solution. The electric current separates the metal in the solution, and the coating is deposited on the metal surface of the article. If the metal in the solution and the metal of the positive terminal are the same, the electricity may remove metal from the terminal to replace the metal taken from the solution.

The thickness of the layer deposited on the article depends on the strength of the electric current and on the duration of the bath. The terms *triple-plated* and *quadruple-plated* indicate various thicknesses of plating, not separate layers deposited on the surface.

Ornamental and protective platings are very thin, usually from $\frac{1}{1,000}$ to $\frac{2}{1,000}$ of an inch thick. For plating gold, silver, copper, zinc, and cadmium, cyanide solutions of the same metals are often used. Copper and zinc may also be plated by acid-sulfate solutions. Chromium is plated with a chromic-acid solution and nickel is plated with nickel sulfate. Other metals plated for commercial use include platinum, lead, and tin. Alloys of two or more metals may be deposited by using a solution of salts of the metals that make up the alloy. Examples of alloys used for plating are brass, black nickel, lead-tin, and bronze.



The longer the article stays in the solution, the heavier the coat of metal deposited on the object will be.

Electroplating is also used to reproduce medals or other objects. This is called *electroforming*. The old name for this process was *galvanoplasty*. One kind of electroforming is the reproduction of type forms and engravings for the printing industry. This is called *electrotyping* (see ELECTROTYPING). In electrotyping, a mold or cast is made in some soft material, such as wax or gutta-percha. The wax is made conductive to electricity by applying a film of graphite or metallic powder. The mold is then set in the electroplating solution and put through the same process as in other forms of electroplating. ELMER C. EASTON

See also ALLOY; ELECTROLYSIS (Industrial Uses); ELECTROTYPING.

Press Syndicate

A Gold-Leaf Electroscope has two strips of gold leaf hanging inside a glass vessel. A charged amber rod touching the metal ball atop the instrument causes the leaves to repel each other.

ELECTROSCOPE, *ee LEK troh scope*, is an instrument that can detect the presence of an electric charge and tell whether the charge is positive or negative. A simple electroscope has a small ball of plant pith hanging by a silk thread from a glass support. When something with a negative charge comes near, the plant pith takes on some of the negative charge. Now the negatively charged plant pith will attract something that is positively charged, and it will repel anything that is negatively charged.

An improved type called the *gold-leaf electroscope* is used in the laboratory. It was first used by Abraham Bennet in 1787. This electroscope has two slender strips of gold leaf hanging from a metallic rod inside a glass vessel. The metallic rod is an electrical conductor. It is inserted into the glass through some nonconducting stopper. Outside the glass the rod has a metal knob on the end. When the rod has no electric charge, the leaves hang straight down. If the knob is touched by a positively charged glass rod, for example, the gold leaves are left with a positive charge, and repel each other at once. They hang from the metal rod like an upside-down V. Now, if a negative charge is brought to the knob, the leaves are neutralized. They collapse and again hang straight down.

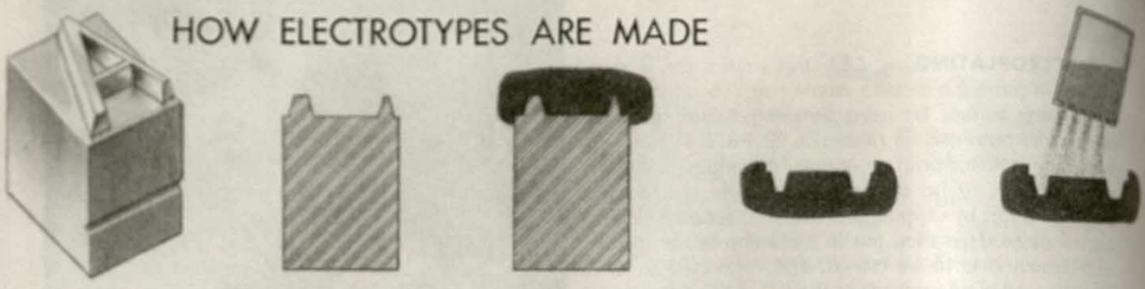
One of the most important uses of the electroscope is the detection of X rays and other causes of electromagnetic radiations. Hospitals use electroscopes to find radium that has been lost. PALMER H. CRAIG

See also COSMIC RAYS; ELECTRICITY; MILLIKAN, ROBERT A.; RADIATION (Protecting Ourselves); X RAYS.

ELECTROSTATIC PRECIPITATION. See AIR CLEANER.

ELECTROSTATICS, the science of static electricity. See ELECTRICITY (Basic Principles of Electricity).

HOW ELECTROTYPES ARE MADE



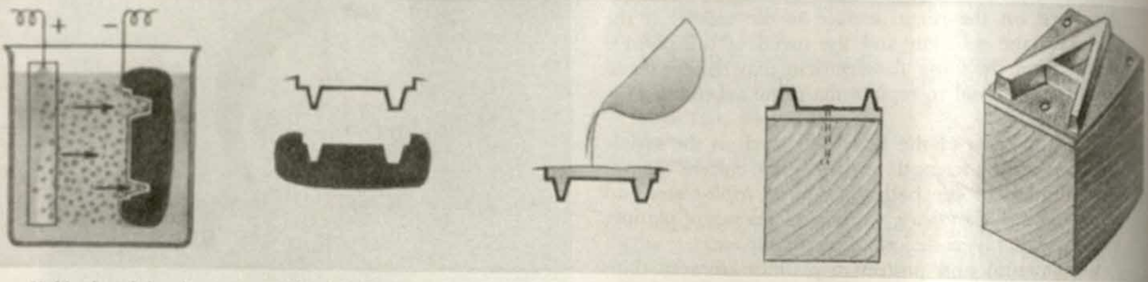
Type to be copied by electrotyping

Cross section of the type

Plastic or wax pressed on type to make mold

Mold is removed from type

Inside of mold coated to conduct electricity



Mold placed in electroplating solution

Metal shell stripped from the mold

Type metal poured into metal shell

Trimmed shell fastened to wooden block

Completed electrotype ready for use

ELECTROTYPING is the process of making metal reproductions of type, engravings, or etchings. This is done by *electrodeposition*, or causing metal to be deposited on a surface by chemical and electrical means. This process is a type of *electroforming*.

Electrotyping is used to print books, magazines, and other commercial matter. Next to stereotyping, it is the cheapest and fastest way to duplicate a printed surface. It is also the most accurate way.

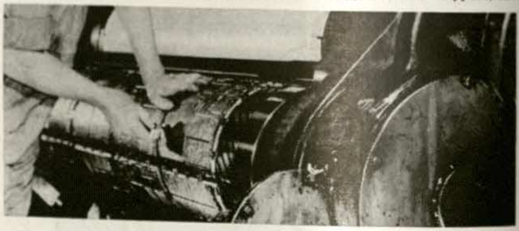
A vinyl plastic or wax mold is first made of the type or other matter to be electrotyped. The surface of plastic molds are then coated with a silver nitrate solution and wax molds with graphite so they will conduct electricity. The mold is hung in a copperplating solution, composed of copper sulfate and sulfuric acid. The mold is then connected to the negative end of a source of electric current. Natural processes of electrolysis deposit a layer of copper on the mold about $\frac{8}{1,000}$ of an inch thick (see Electrolysis). This requires about two hours. The shell of copper is then stripped from the mold and trimmed to size. Type metal is poured onto the back, and the cast shell shaved to standard thickness. Edges are trimmed and rounded, and the printing surface is made flat. Sometimes the plate is curved when it is to be used on a rotary press that prints from cylinders.

There are several variations of this process. Nickel electrotypes are made by first depositing about $\frac{1}{1,000}$ of an inch of nickel on the mold. The mold is then transferred to a copper solution, where about $\frac{7}{1,000}$ of an inch of copper is deposited on the back of the nickel. Sometimes copper electrotypes are nickel-plated to make them harder and more resistant to wear. When an exceptionally long run, or large number of copies, is desired, copper electrotypes are plated with chromium. For the best electrotypes, the mold is made in thin sheet lead instead of plastic or wax. S. W. Hayter

See also Electroplating; Printing; Stereotyping.

Finished Electrotypes are put on a press. The plates are curved for rotary presses like those that print the World Book.

Int'l. Assn. of Electrotypers & Stereotypers, Inc.



ELECTRUM, a natural alloy of gold and silver. See Gold (Gold in Sea Water).

ELEGY, *EHL ee jih*, is a gravely thoughtful poem, often on the subject of someone's death. John Milton's "Lycidas" bemoans the death of a young friend, Edward King. Percy B. Shelley lamented the death of John Keats in "Adonais." Lord Tennyson's "In Memoriam" mourned the death of Arthur Henry Hallam. Traditionally, an elegiac writer mourns the death, describes the funeral, questions fate, and then finds a way to reconcile himself to what has happened. But there are many variations on this traditional elegiac pattern.

Elegies also meditate on subjects other than death. Milton attacked the corruption in the church, and Tennyson pondered the influence of science on traditional attitudes. Thomas Gray, in his "Elegy Written in a Country Churchyard," thought of all the unknown men and women buried in the churchyard and wondered what their lives might have meant. Rainer Maria Rilke's *Duino Elegies* have a mournful theme but no direct connection with death. *Pastoral* elegies like "Lycidas" present figures as shepherds in a rural setting. This Greek device may be used satirically. M. L. Rosenthal

ELEMENT, CHEMICAL. All matter is made up of one or more essentially different substances. These basic substances are called *chemical elements*. Among them are iron, gold, sulfur, and oxygen. There are 103 known chemical elements, some of which do not occur in nature but are manufactured by man. These have been produced artificially by the bombardment of known elements with atomic particles.

A number of elements were in common use before the dawn of history. Among these were copper, tin, lead, gold, silver, iron, and sulfur. In general, such well-known elements are the ones that are found in a pure form in nature or which can be separated from their ores at relatively low temperatures. The ancient people did not know that these substances were elements. The Greeks, for example, regarded all substances as being made up of air, water, fire, and earth. This theory was reflected for a long time in literature and the arts.

Elements get their names from many sources. The names of some come from Greek and Latin. *Bromine* comes from the Greek word for *stench* and was named because of its odor. The gas *helium* gets its name from *helios*, the Greek word for *sun*.

Each known element has a standard symbol, which will be found in the table of the elements and their discoverers. In some cases, the symbol is the first letter of the name of the element, as in C for carbon, O for oxygen, and H for hydrogen. Often when there are two elements beginning with the same letter, the first two letters of the name are used, as in Ca for calcium, and Co for cobalt. In some cases, the symbol is taken from the old Latin name of the element. Pb, the symbol for lead, comes from the Latin word *plumbum*, from which our word *plumber* is also taken.

Under ordinary temperatures and pressures, two of the elements are liquids, eleven are gases, and the rest are solids. Mercury and bromine are the liquids. The gases are oxygen, hydrogen, nitrogen, fluorine, chlorine, argon, neon, helium, xenon, krypton, and radon.

Oxygen is by far the most abundant of the elements on the earth. It makes up about 21 per cent of the air, 89 per cent of the water, 65 per cent of the human body, and 50 per cent of the earth's crust. These facts make it possible to say that oxygen makes up about half of the world near the earth's surface. Silicon is the second most abundant element. It makes up about 25 per cent of the

(Text continued on page 174.)

TABLE OF THE ELEMENTS AND THEIR DISCOVERERS

NAME	SYMBOL	*ATOMIC WEIGHT	ATOMIC NUMBER	SPECIFIC GRAVITY	DISCOVERER	COUNTRY OF DISCOVERY	DATE OF DISCOVERY
Actinium	Ac	[227]	89	———	André Debierne	France	1899
Aluminum	Al	26.98	13	2.70	Hans Christian Oersted	Denmark	1825
Americium	Am	[243]	95	———	G. T. Seaborg; R. A. James; L. O. Morgan; A. Ghiorso	United States	1945
Antimony	Sb	121.76	51	6.691		Known to Ancients	
Argon	Ar	39.944	18	.00178	Sir William Ramsay; Baron Rayleigh	Scotland	1894
Arsenic	As	74.92	33	5.7		Known to Ancients	
Astatine	At	[210]	85	———	D. R. Corson; K. R. MacKenzie; E. Segrè	United States	1940
Barium	Ba	137.36	56	3.5	Sir Humphry Davy	England	1808
Berkelium	Bk	[249]	97	———	G. T. Seaborg; S. G. Thompson; A. Ghiorso	United States	1949
Beryllium	Be	9.013	4	1.85	Friedrich Wöhler; A. A. Bussy	Germany; Fr.	1828
Bismuth	Bi	208.99	83	9.80		Known to Ancients	
Boron	B	10.82	5	2.45	H. Davy; J. L. Gay-Lussac; L. J. Thénard	England; Fr.	1808
Bromine	Br	79.916	35	3.12	Antoine J. Balard	France	1826
Cadmium	Cd	112.41	48	8.65	Friedrich Stromeyer	Germany	1817
Calcium	Ca	40.08	20	1.55	Sir Humphry Davy	England	1808
Californium	Cf	[251]	98	———	G. T. Seaborg; S. G. Thompson; A. Ghiorso; K. Street, Jr.	United States	1950
Carbon	C	12.011	6	3.52		Known to Ancients	
Cerium	Ce	140.13	58	6.90	W. von Hisinger; J. Berzelius; M. Klaproth	Sweden; Germany	1803
Cesium	Cs	132.91	55	1.90	Gustav Kirchhoff, Robert Bunsen	Germany	1860
Chlorine	Cl	35.457	17	0.0032	Karl Wilhelm Scheele	Sweden	1774
Chromium	Cr	52.01	24	7.1	Louis Vauquelin	France	1797
Cobalt	Co	58.94	27	8.9	Georg Brandt	Sweden	1737
Copper	Cu	63.54	29	8.92		Known to Ancients	
Curium	Cm	[247]	96	———	G. T. Seaborg; R. A. James; A. Ghiorso	United States	1944
Dysprosium	Dy	162.51	66	———	Paul Émile Lecoq de Boisbaudran	France	1886
Einsteinium	Es	[254]	99	———	Argonne Lab.; Los Alamos Lab.; U. of Calif.	United States	1952
Erbium	Er	167.27	68	4.77	Carl Mosander	Sweden	1843
Europium	Eu	152.0	63	———	Eugène Demarçay	France	1901
Fermium	Fm	[253]	100	———	Argonne; Los Alamos; U. of Calif.	United States	1953
Fluorine	F	19.00	9	0.0017	Henri Moissan	France	1886
Francium	Fr	[223]	87	———	Marguerite Perey	France	1939
Gadolinium	Gd	157.26	64	———	Jean de Marignac	Switzerland	1880
Gallium	Ga	69.72	31	5.9	Paul Émile Lecoq de Boisbaudran	France	1875
Germanium	Ge	72.60	32	5.36	Clemens Winkler	Germany	1886
Gold	Au	197.0	79	19.3		Known to Ancients	

*A number in brackets indicates the mass number of the most stable isotope.

PERIODIC CHART OF THE ELEMENTS

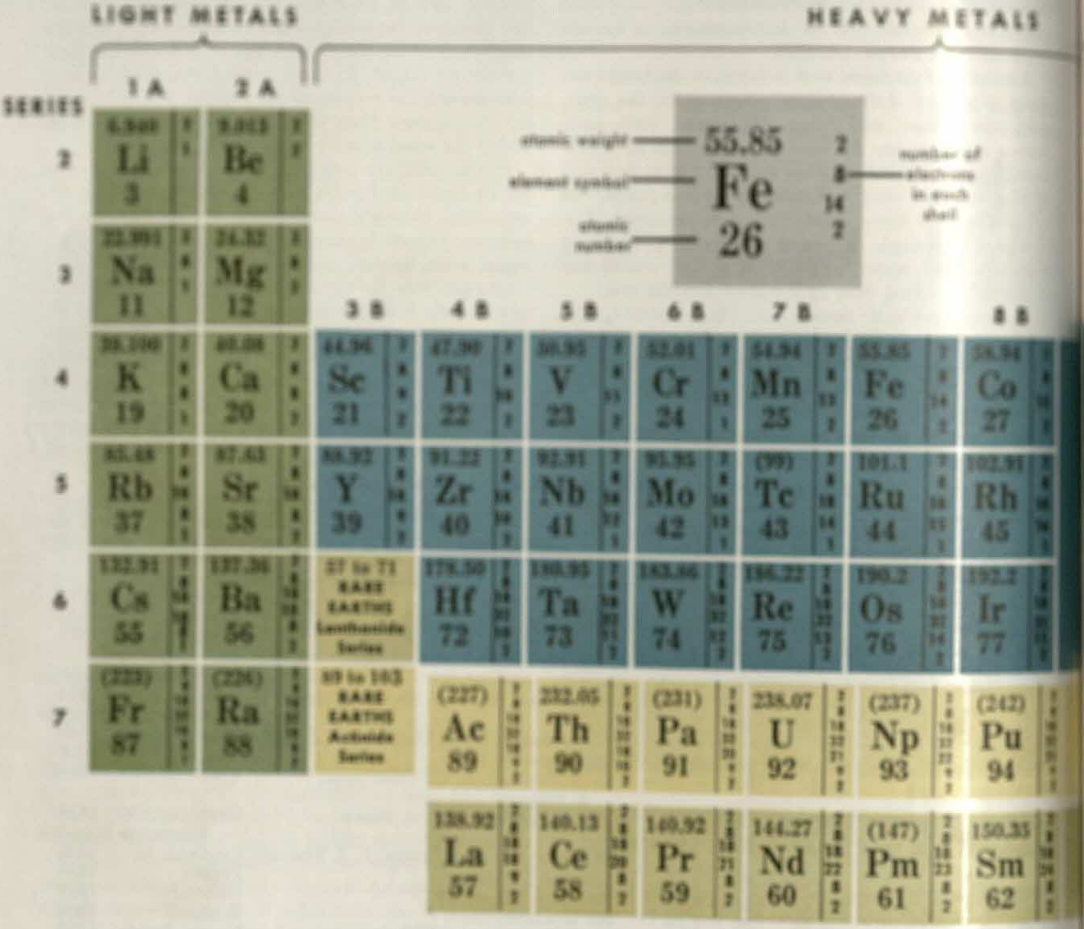
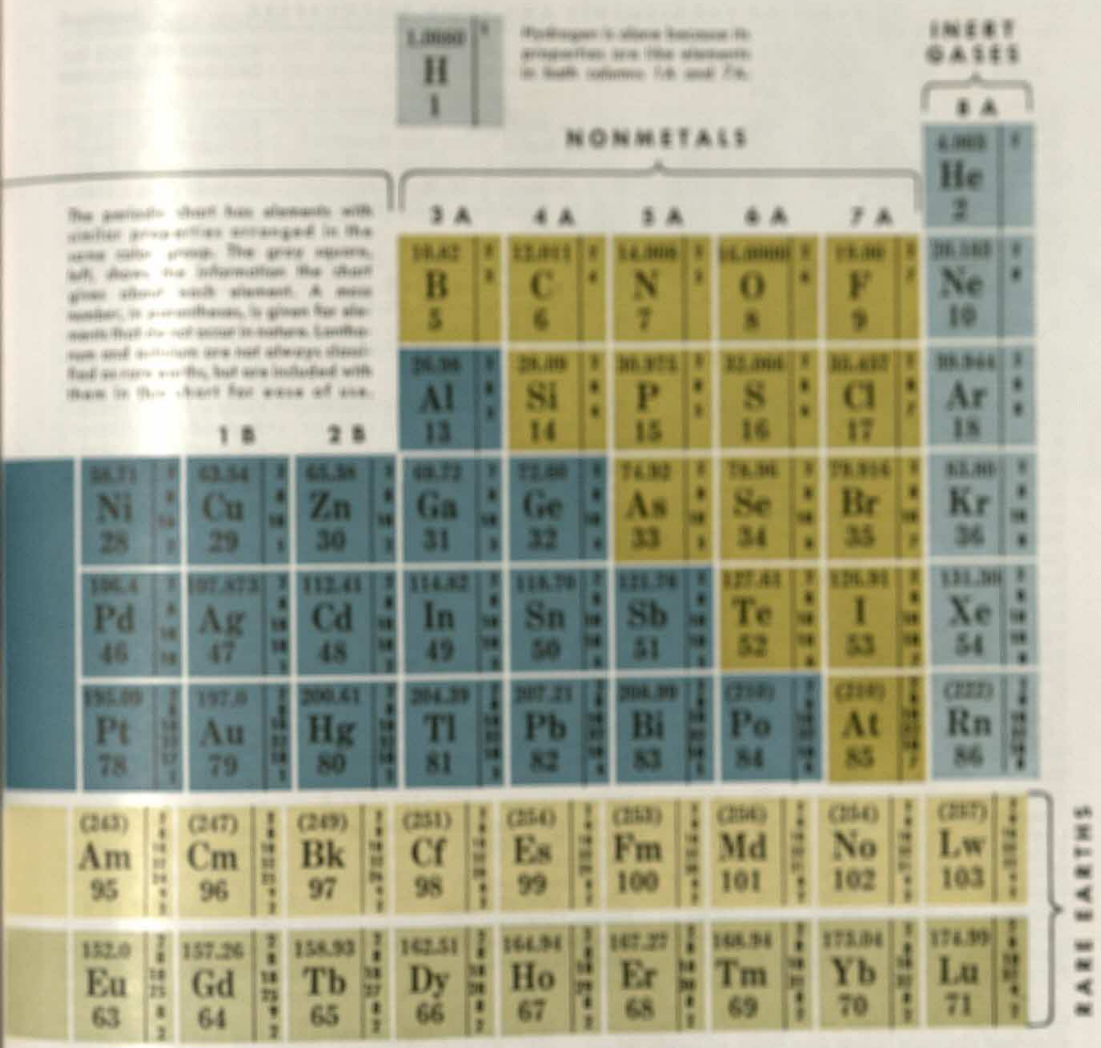

LIGHT METALS
HEAVY METALS
1 A
2 A
SERIES
2
3
4
5
6
7
atomic weight
element symbol
atomic number
55.85
Fe
26
2
8
14
2
number of electrons in each shell
3 B
4 B
5 B
6 B
7 B
8 B
6.940 Li 3
9.013 Be 4
22.991 Na 11
24.32 Mg 12
39.100 K 19
40.08 Ca 20
44.96 Sc 21
47.90 Ti 22
50.95 V 23
52.01 Cr 24
54.94 Mn 25
55.85 Fe 26
58.94 Co 27
85.48 Rb 37
87.63 Sr 38
88.92 Y 39
91.22 Zr 40
92.91 Nb 41
95.95 Mo 42
(99) Tc 43
101.1 Ru 44
102.91 Rh 45
132.91 Cs 55
137.36 Ba 56
57 to 71 RARE EARTHS Lanthanide Series
178.50 Hf 72
180.95 Ta 73
183.86 W 74
186.22 Re 75
190.2 Os 76
192.2 Ir 77
(223) Fr 87
(226) Ra 88
89 to 103 RARE EARTHS Actinide Series
(227) Ac 89
232.05 Th 90
(231) Pa 91
238.07 U 92
(237) Np 93
(242) Pu 94
138.92 La 57
140.13 Ce 58
140.92 Pr 59
144.27 Nd 60
(147) Pm 61
150.35 Sm 62

TABLE OF THE ELEMENTS AND THEIR DISCOVERERS

NAME	SYMBOL	*ATOMIC WEIGHT	ATOMIC NUMBER	SPECIFIC GRAVITY	DISCOVERER	COUNTRY OF DISCOVERY	DATE OF DISCOVERY
Hafnium	Hf	178.50	72	———	Dirk Coster; Georg von Hevesy	Denmark	1923
Helium	He	4.003	2	0.00018	Sir William Ramsay; Nils Langlet; P. T. Cleve	Scotland; Sweden	1895
Holmium	Ho	164.94	67	———	P. T. Cleve	Sweden	1879
Hydrogen	H	1.0080	1	0.00009	Henry Cavendish	England	1766
Indium	In	114.82	49	7.3	Ferdinand Reich; H. Richter	Germany	1863
Iodine	I	126.91	53	4.93	Bernard Courtois	France	1811
Iridium	Ir	192.2	77	22.4	Smithson Tennant	England	1804
Iron	Fe	55.85	26	7.86		Known to Ancients	
Krypton	Kr	83.80	36	0.0037	Sir William Ramsay; M.W. Travers	Great Britain	1898
Lanthanum	La	138.92	57	6.15	Carl Mosander	Sweden	1839
Lawrencium	Lw	[257]	103	———	A. Ghiorso; T. Sikkeland; A. E. Larsh; R. M. Latimer	United States	1961
Lead	Pb	207.21	82	11.34		Known to Ancients	
Lithium	Li	6.940	3	0.534	Johann Arfvedson	Sweden	1817
Lutetium	Lu	174.99	71	———	Georges Urbain	France	1907



Hydrogen is alone because its properties are like elements in both columns 1A and 7A.

1.0080 H 1

INERT GASES

NONMETALS

The periodic chart has elements with similar properties arranged in the same color group. The gray square, left, shows the information the chart gives about each element. A mass number, in parentheses, is given for elements that do not occur in nature. Lanthanum and actinium are not always classified as rare earths, but are included with them in the chart for ease of use.

	1 B	2 B	3 A	4 A	5 A	6 A	7 A	8 A
								4.003 He 2
			10.82 B 5	12.011 C 6	14.008 N 7	16.0000 O 8	19.00 F 9	20.183 Ne 10
			26.98 Al 13	28.09 Si 14	30.975 P 15	32.066 S 16	35.457 Cl 17	39.944 Ar 18
58.71 Ni 28	63.54 Cu 29	65.38 Zn 30	69.72 Ga 31	72.60 Ge 32	74.92 As 33	78.96 Se 34	79.916 Br 35	83.80 Kr 36
106.4 Pd 46	107.873 Ag 47	112.41 Cd 48	114.82 In 49	118.70 Sn 50	121.76 Sb 51	127.61 Te 52	126.91 I 53	131.30 Xe 54
195.09 Pt 78	197.0 Au 79	200.61 Hg 80	204.39 Tl 81	207.21 Pb 82	209.00 Bi 83	(210) Po 84	(210) At 85	(222) Rn 86

RARE EARTHS

(243) Am 95	(247) Cm 96	(249) Bk 97	(251) Cf 98	(254) Es 99	(253) Fm 100	(256) Md 101	(254) No 102	(257) Lw 103
152.0 Eu 63	157.26 Gd 64	158.93 Tb 65	162.51 Dy 66	164.94 Ho 67	167.27 Er 68	168.94 Tm 69	173.04 Yb 70	174.99 Lu 71

TABLE OF THE ELEMENTS AND THEIR DISCOVERERS

NAME	SYMBOL	*ATOMIC WEIGHT	ATOMIC NUMBER	SPECIFIC GRAVITY	DISCOVERER	COUNTRY OF DISCOVERY	DATE OF DISCOVERY
Magnesium	Mg	24.32	12	1.74	Sir Humphry Davy	England	1808
Manganese	Mn	54.94	25	7.2	Johann Gahn	Sweden	1774
Mendelevium	Md	[256]	101	———	G. T. Seaborg; A. Ghiorso; B. Harvey; G. R. Choppin; S. G. Thompson	United States	1955
Mercury	Hg	200.61	80	13.55		Known to Ancients	
Molybdenum	Mo	95.95	42	10.2	Karl Wilhelm Scheele	Sweden	1778
Neodymium	Nd	144.27	60	6.9	C. F. Auer von Welsbach	Austria	1885
Neon	Ne	20.183	10	0.0009	Sir William Ramsay; M. W. Travers	England	1898
Neptunium	Np	[237]	93	———	E. M. McMillan; P. H. Abelson	United States	1940
Nickel	Ni	58.71	28	8.90	Axel Cronstedt	Sweden	1751
Niobium	Nb	92.91	41	8.4	Charles Hatchett	England	1801
Nitrogen	N	14.008	7	0.00125	Daniel Rutherford	Scotland	1772
Nobelium	No	[254]	102	———	Nobel Institute for Physics	Sweden	1957
Osmium	Os	190.2	76	22.48	Smithson Tennant	England	1804
Oxygen	O	16.0000	8	0.001429	Joseph Priestley; Karl Wilhelm Scheele	England; Sweden	1774

*At. weight in brackets indicates the mass number of the most stable isotope.

NAME	SYMBOL	*ATOMIC WEIGHT	ATOMIC NUMBER	SPECIFIC GRAVITY	DISCOVERER	COUNTRY OF DISCOVERY	DATE OF DISCOVERY
Palladium	Pd	106.4	46	12.16	William Wollaston	England	1803
Phosphorus	P	30.975	15	1.83	Hennig Brand	Germany	1669
Platinum	Pt	195.09	78	21.37	Julius Scaliger	Italy	1557
Plutonium	Pu	[242]	94	———	G. T. Seaborg; J. W. Kennedy; E. M. McMillan; A. C. Wahl	United States	1940
Polonium	Po	[210]	84	———	Marie Curie	France	1898
Potassium	K	39.100	19	0.86	Sir Humphry Davy	England	1807
Praseodymium	Pr	140.92	59	6.5	C. F. Auer von Welsbach	Austria	1885
Promethium	Pm	[147]	61	———	J. A. Marinsky; Lawrence E. Glendenin; Charles D. Coryell	United States	1945
Protactinium	Pa	[231]	91	———	Otto Hahn; Lise Meitner; Frederick Soddy; John Cranston	Germany; England	1917
Radium	Ra	[226]	88	5.0	Pierre and Marie Curie	France	1898
Radon	Rn	[222]	86	0.00973	Friedrich Ernst Dorn	Germany	1900
Rhenium	Re	186.22	75	20.53	Walter Noddack; Ida Tacke; Otto Berg	Germany	1925
Rhodium	Rh	102.91	45	12.5	William Wollaston	England	1803
Rubidium	Rb	85.48	37	1.53	R. Bunsen; G. Kirchhoff	Germany	1861
Ruthenium	Ru	101.1	44	12.2	Karl Klaus	Russia	1844
Samarium	Sm	150.35	62	7.7	Paul Émile Lecoq de Boisbaudran	France	1879
Scandium	Sc	44.96	21	2.5	Lars Nilson	Sweden	1879
Selenium	Se	78.96	34	4.8	Jöns Berzelius	Sweden	1817
Silicon	Si	28.09	14	2.4	Jöns Berzelius	Sweden	1823
Silver	Ag	107.873	47	10.5		Known to Ancients	
Sodium	Na	22.991	11	0.97	Sir Humphry Davy	England	1807
Strontium	Sr	87.63	38	2.6	A. Crawford	Scotland	1790
Sulfur	S	32.066	16	2.0		Known to Ancients	
Tantalum	Ta	180.95	73	16.6	Anders Ekeberg	Sweden	1802
Technetium	Tc	[99]	43	———	Carlo Perrier; Emilio Segrè	Italy	1937
Tellurium	Te	127.61	52	6.24	Franz Müller	Romania	1782
Terbium	Tb	158.93	65	———	Carl Mosander	Sweden	1843
Thallium	Tl	204.39	81	11.85	Sir William Crookes	England	1861
Thorium	Th	232.05	90	11.2	Jöns Berzelius	Sweden	1828
Thulium	Tm	168.94	69	———	Per Theodor Cleve	Sweden	1879
Tin	Sn	118.70	50	7.3		Known to Ancients	
Titanium	Ti	47.90	22	4.5	William Gregor	England	1791
Tungsten	W	183.86	74	19.3	Fausto and Juan José de Elhuyar	Spain	1783
Uranium	U	238.07	92	18.7	Martin Klaproth	Germany	1789
Vanadium	V	50.95	23	5.96	Nils Sefström	Sweden	1830
Xenon	Xe	131.30	54	0.0058	Sir William Ramsay; M. W. Travers	England	1898
Ytterbium	Yb	173.04	70	5.51	Jean de Marignac	Switzerland	1878
Yttrium	Y	88.92	39	3.80	Johann Gadolin	Finland	1794
Zinc	Zn	65.38	30	7.14	Andreas Marggraf	Germany	1746
Zirconium	Zr	91.22	40	6.4	Martin Klaproth	Germany	1789

*A number in brackets indicates the mass number of the most stable isotope.

earth's crust. Aluminum and iron are the next most abundant elements. These four make up nearly 90 per cent of the crust.

Elements differ from each other because of the differences in their atoms. The atoms of each element are made up of electrons, light particles bearing a charge of negative electricity; protons, heavy particles bearing a charge of positive electricity; and neutrons, as heavy as protons but without electrical charge.

The atoms of each element have an atomic weight which shows the relationship between the weight of that atom and the weight of oxygen, which is arbitrarily set at 16. For some elements that do not occur in nature, especially the radioactive elements, the term *mass number* is used instead of atomic weight. Atoms also have an atomic number, which is the number of protons in the nucleus of the atom. See ATOM (Properties).

The way the atoms of any element will combine with each other to form compounds depends upon the electrons which the element contains. The periodic table groups elements in terms of their atomic numbers. Grouped by their atomic numbers, the atoms seem to fall into a regular pattern with breaks at specific intervals. Such breaks occur with the elements helium (atomic number 2), neon (10), argon (18), krypton (36), xenon (54), and radon (86). These elements all resemble each other and are all inert gases group 8A. With the exception of radon, they are all present in the air. They are unlike other elements in that they do not form compounds. There are similar resemblances in the atoms in any of the other vertical groupings in the chart.

There are shortcomings in the periodic chart. Sometimes the resemblance within families is slight. But the gaps revealed in atomic numbers led to the discovery of new elements which now fill these gaps.

An element may have *isotopes*, or atoms which are chemically alike but differ from each other in weight (see ISOTOPE).

GEORGE L. BUSH and RALPH E. LAPP

Related Articles. See the separate articles in WORLD BOOK on each of the chemical elements in the *table* with this article. See also the following articles:

Atom
Chemistry
Mendeleev, Dmitri I.
Radioactivity
Rare Earth
Transuranium Elements

ELEMENTARY SCHOOL, is a school for children from 5 or 6 to 12 or 14 years old. Most elementary schools have either six or eight grades. A grade corresponds roughly to a year's work in school. Many elementary schools include *kindergartens* for children who are 5 years old (see KINDERGARTEN). Pittsburgh and some other cities have *primary-unit schools* that include a kindergarten and the first three grades. In these cities, larger *intermediate schools* include fourth, fifth, and sixth grades for older children.

Elementary schools develop the child's physical, social, and mental abilities. They teach children to read, write, and use numbers, and introduce them to art, geography, history, music, science, and many other subjects. In addition, elementary schools teach children social and personal responsibility. They develop the children's ideas of right and wrong and their duties as good citizens. When they complete elementary school, boys and girls are ready to attend junior high school or high school.

Elementary Schools in the United States

The United States has about 120,000 elementary schools, attended by about 30,000,000 children. Most children in the United States attend tax-supported public elementary schools. But the country has about 11,000 private or church elementary schools, attended by about 4,000,000 children. Entrance fees and gifts often help to support private and church schools.

Attendance. Every child in the United States must attend elementary school. State laws vary, but the usual beginning age is 6. Through a Supreme Court decision in 1925, parents can choose whether their children attend a private or public school. The states have various ways of inspecting private schools. These inspections ensure that elementary education throughout the states meets certain general requirements.

The school year usually lasts about nine months, giving the boys and girls a long summer vacation. This practice comes from a time when most people lived on farms and needed their children to help with the work during summer. Some elementary schools have summer sessions for children who are specially gifted or who need special help. But many elementary schools close during June, July, and August.

The school day in most elementary schools lasts about five hours. Younger children usually have a shorter day than five hours. Many elementary schools, especially in country areas, have buses to bring the children to school and to take them home.

Instruction in elementary schools includes learning how to read, write, and use numbers. In addition to these basic skills, the children learn about the history of the United States and the geography of the world. Elementary-school teachers introduce the children to science. They draw their lessons from aeronautics, astronomy, biology, chemistry, geology, physics, zoology, and other scientific studies. The children study science textbooks and learn many of the lessons from films, magazines, and weekly newspapers specially designed for youngsters. Many elementary-school programs include instruction in agriculture, arts and crafts, homemaking, and social studies. Elementary-school teachers usually give the children lessons in health and hygiene. And the children learn how to play sports and games during their recreation periods.

Creative Playthings, Inc.

Elementary School Children work with creative toys such as a number sorter in learning the sequence and grouping of numbers.

In each elementary-school grade, a child learns new and increasingly difficult material. He also reviews the things he has learned in previous grades. For example, a fourth-grader learns new facts about the earth and the people who live on it. In the third grade he reviews the things he learned about other people and the earth. Teachers also try to provide materials of varying levels of difficulty in each lesson, so that each child will learn as much as he can. They do not simply force a child to learn through memorizing and drill. Rather, they try to create an interest in and an understanding of the material. Learning facts is a basic part of elementary-school work. But teaching children how to find facts and how to use them has great importance in elementary-school instruction.

Buildings and Equipment. Before the 1900's, the typical American elementary school was a one-room building. Many songs and stories tell about "the little red schoolhouse." Children of all ages sat together at wooden desks bolted to the floor. They had to share the school's few textbooks. The teacher soaked the floor with oil to prevent dust from gathering. A wood or coal stove in a corner of the room provided heat on cold winter days. The school had no electric lights, and walls had few pictures or decorations. The teacher used a black slate chalkboard to present the lessons. All the furniture was painted in dark colors, usually dark brown. The United States still has about 24,000 one-room elementary schools in operation. Equipment has greatly improved, but all the children have to study in one room.

New, larger elementary schools have many light, airy rooms, often with the rooms all on a single floor. Each grade or a subdivision of a grade usually has its own room. The rooms often have outside doors to the playground or to individual outdoor classroom areas. The teachers can easily move the desks and other furniture, and adjust the furniture to the size of the child. The rooms have many books and other study materials. The floors have colorful tile surfaces. Soft electric lights

Lil & Al Bloom

Two Eager Third-Graders seem to know all the answers to the teacher's questions in an oral quiz. In city elementary schools, each grade has its own teacher and meets in a separate classroom.

provide illumination, and the walls have many colorful pictures, maps, and other decorations. Automatic temperature controls keep each room at the right temperature for good learning. The teacher uses a green chalkboard designed for easy reading. The children can use cork bulletin boards to display their work and to post interesting information and pictures. A large elementary school may have an art room, an auditorium, a gymnasium, a kitchen, a library, a lunchroom, a music room, and a room for the teachers. With a lunchroom and kitchen, children can have a hot noon meal. Teachers use motion pictures, phonograph records, radio, and television to help children learn.

Elementary Schools in Canada

Canadian elementary schools have almost the same aims and organization as those in the United States. They teach children from 5 or 6 to 12 or 14 years old, and offer instruction in six or eight grades. About 2,900,000 boys and girls attend elementary schools. Studies resemble those in the United States. A larger proportion of children attend public schools than in the United States. But public schools in Canada include many schools in which religious education is offered. Canada has about 850 private elementary and secondary schools. About 80,000 children attend the elementary grades in these schools.

Each province has its own public school system. Taxes and some federal grants support the schools. The government also maintains a number of elementary schools for Eskimos and Indians. Many public elementary schools, particularly in Quebec, are Roman Catholic French-language schools. See CANADA (Education).

History

Some of the first elementary schools appeared in ancient Greece and Rome. They taught reading, writing, and the use of numbers. During the Middle Ages, parish priests and church schools gave a basic education in Latin to small groups of boys. During the Reformation, the first public elementary schools appeared in Germany in the 1500's. After 1800, France, Germany, Great Britain, and other European countries developed national systems of elementary schools.

The first elementary schools in the United States appeared shortly after the first colonists landed in New England. A Massachusetts law of 1642 ordered that children should be taught to read. Another Massachusetts law in 1647 required that every town of 50 or more householders should establish a school to teach reading and writing. Early schools seldom taught more than reading, writing, and arithmetic. See COLONIAL LIFE IN AMERICA (Education); PIONEER LIFE (Education).

The Land Ordinance of 1785 dealt with the organization of new lands in the west. It provided that one section of land in each new township should be used to establish schools.

But the federal government left the actual establishment of schools to the states. In 1816, the constitution of the new state of Indiana directed the legislature to establish a free public school system. Other states followed Indiana's example. Pennsylvania passed its Free-School Act in 1834. This law allowed local towns and districts in Pennsylvania to join a state public school system. Taxes supported the new public elementary schools. Massachusetts passed the first state compulsory school-attendance law in 1852. This law required all children from 8 to 14 to spend at least 12 weeks a year in school. After 1918, every state had a system of public elementary schools and attendance laws. Many southern states modified their attendance laws after 1954, when the Supreme Court ruled that racial segregation in public schools was unconstitutional.

After the Civil War, elementary school education began to change. Studies came to include many new subjects, such as art, geography, history, music, and science. Teachers received more careful training, often through state teachers' colleges. In 1847, the Quincy Grammar School in Boston became the first public school to have a complete system of separate grades for the children. In 1848, its new building became the first to have a separate room for each grade. The elementary schools gradually came to place less emphasis on memorizing and drill, and more on understanding and solving problems.

HAROLD D. DRUMMOND

Related Articles in WORLD BOOK include:

Consolidated School
Education,
  History of
High School
Junior High
  School
Kindergarten
Learning
Nursery School
Platoon School
School
Teaching

ELEMENTARY SCIENCE. See NATURE STUDY and SCIENCE with their lists of Related Articles.

Ewing Galloway

Wild Elephants, the largest and most powerful land animals in the world, live only in the tropical jungles and grassy plains of Africa and southern Asia. Tame elephants can be taught many tricks, and are always a featured attraction at circuses and zoos. In Africa and India, they are often trained to do heavy work.

ELEPHANT is the largest animal that walks on four legs. It is one of the most interesting of all the large animals. No other creature has been so much exhibited. It has skin an inch thick, yet has such a poor heating system that its owner is as easily frosted as a bean plant. Nor is there another animal with its nose drawn out into a long trunk that it uses as a hand, one whose skull is 15 inches thick, or whose front teeth are so large.

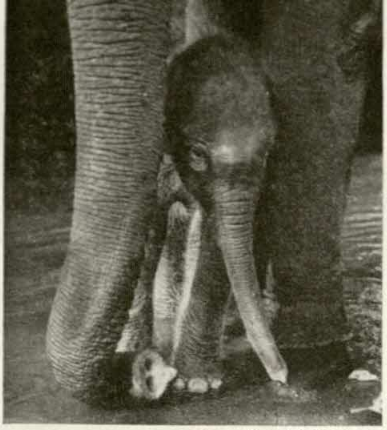
Today, in circuses and zoos, elephants are chiefly used for exhibition purposes, since people never tire of watching them. For several thousand years, however, they have been tamed and used to serve man. The earliest use of elephants was for war. King Porus of India used them in fighting against Alexander the Great. Hannibal took 37 elephants with him across the Alps into Italy to fight the Romans. Elephants were of little value against the Romans, but Hannibal's father, Hamilcar, used "war elephants" with terrible effect against the barbarians near Carthage in North Africa. These elephants carried soldiers on their backs, and their tusks were armed with swords. If the elephants stampeded, however, they often killed the men of their own army.

Kinds of Elephants

There are only two kinds of elephants, the Indian elephant and the African elephant. Indian elephants are found wild today, chiefly in India, Burma, Thailand, Ceylon, and Sumatra. African elephants are found only in Africa, chiefly in and around Ethiopia. Once they lived everywhere south of the Sahara. In 1906, the pygmy elephant—only about 5 feet high—was found in West Africa. Scientists soon decided that it was not a separate species, but a dwarf African elephant.

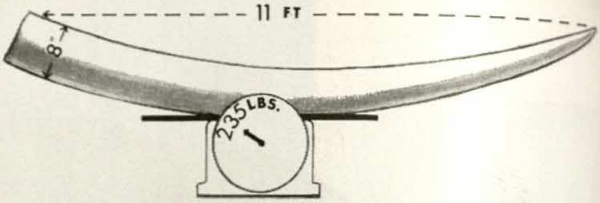
African and Indian elephants are different in many ways. As a general rule, both male and female African elephants have well-developed tusks, that grow to a much larger size than those of the Indian elephant. The African elephant also has a more rounded forehead, and his ears are larger than those of his Asiatic cousin. The lower end of the trunk is also different in the two kinds, or species, of elephants. The African elephant has two nearly equal, fingerlike knobs at the end of its trunk. The Asiatic elephant's trunk has only one knob. The African elephant's shoulder is the highest point of its body, and the middle of its back is hollowed. The Indian elephant's back is arched and higher than its shoulder. African elephants are also darker than Indian elephants. They have a rougher skin, and seem to be able to stand the hot sun better.

Africa was probably the original home of elephants, but they later spread all over Asia, Europe, and North America. The big, hairy, prehistoric elephants were called *mammoths* (see MAMMOTH). They were common in Siberia and many fossil tusks are found there. Specimens with hair and flesh have been found frozen in the ice, and scientists have actually tasted the flesh. Fossil remains of very small elephants, about 3 feet high, have been found in Malta. Still older elephant-like animals,



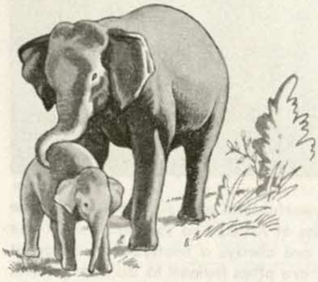
From *The Little Elephant,* illustrated by Ylla, written by Arthur Gregor and published by Harper & Brothers.

A Baby Elephant weighs from 160 to 200 pounds at birth. A full-grown elephant weighs from 8,000 to 14,000 pounds. A young elephant follows its mother for at least 3 or 4 years.



The Largest Tusk ever found, that of an African bull elephant, weighed 235 pounds. It was 11 feet long and 8 inches thick. Hard elephant tusks supply the best ivory in the world.

The Ivory Tusks, *above,* vary in size, but many are 6 feet long. Elephants use their tusks to grub food, fight, and to carry objects.



A Mother Elephant uses her trunk to guide her baby gently along the trail, *left.* Yet the trunk is strong enough to carry heavy logs, *right.*

Ylla, Rapho-Guillumette

the *mastodons,* once lived in North America, but they died out about 20,000 years ago (see MASTODON).

The Elephant's Body

A very large African bull elephant will measure 11½ feet high at the shoulder and weigh 12,000 to 14,000 pounds. Jumbo, P. T. Barnum's great circus elephant, measured 10 feet 7 inches at the shoulder and weighed 12,000 pounds. African cow elephants are usually about 1½ feet less in height than the males and weigh about 2 tons less. Indian elephants are smaller than African elephants. The average height of full-grown males is about 9 feet. Dr. G. W. Crile, who cut up a dead elephant, found that its heart weighed 57 pounds, its liver weighed 235 pounds, and its lungs weighed 300 pounds.

Trunk. An elephant's trunk, said the explorer Carl Akeley, "is the most extraordinary part of this most extraordinary animal." The trunk of an elephant is an amazing structure. It is about 6 feet long, and is a 300-pound mass of tough, interwoven sinews and muscles. It is boneless, perfectly flexible, and unbelievably strong. With it the elephant can shoot a stream of water, lift a ton's weight and toss it easily away, or pick up a peanut or pluck a blade of grass. With its trunk, the elephant can drink, smell, feed itself, perform tasks, caress its mate or its young, and fight its enemies.

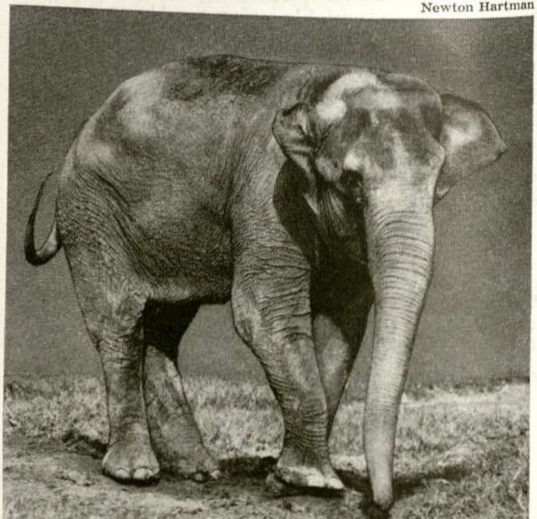
Tusks. An elephant's tusks are its enormously developed upper cutting teeth. The tusks of a large African bull elephant will often weigh 80 pounds each, and one tusk is known to weigh 235 pounds. This tusk is 8 inches thick and 11 feet long. An elephant uses its tusks for grubbing food, for fighting, and for carrying objects. Man uses the ivory of the tusks chiefly for making billiard balls. See IVORY.

Teeth. The grinding teeth of the elephant—12 in all—are peculiar. Only four of them are in place at any one time, one on each side of each jaw. The new teeth form at the back of the mouth and keep pushing forward for use as the old ones in front are worn down and finally lost. It gets its last teeth when it is about 40 years old. In its lifetime it has 24 teeth in all.

Legs and Feet. An elephant's legs are great straight pillars, as they must be to support its bulk. The elephant

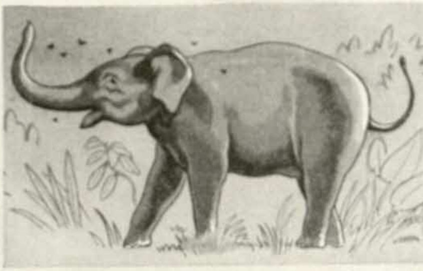
The Indian Elephant has a gray hide, lighter in tone and somewhat smoother in texture than that of its African cousin. Indian elephants are sometimes considered sacred by the Hindus.

Newton Hartman

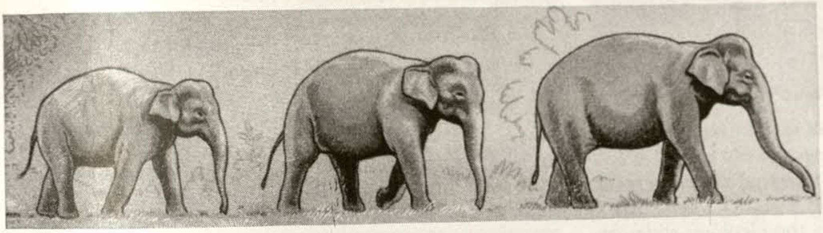


Ewing Galloway

An Elephant Cools Off on a hot day by showering himself with his trunk. Heat bothers elephants, and they often rest in the shade.


The Skin of a Wild Elephant is thick, but sensitive. The bite of a gadfly will draw blood. Elephants often plaster clay on open wounds.

Elephants Curl Their Trunks out of the way when they fight. They live in large herds that seem to be peaceable most of the time.


A Lead Elephant uses his flexible trunk to test a trail, while the herd follows in single file. Elephants have only one gait, a kind of gliding shuffle.

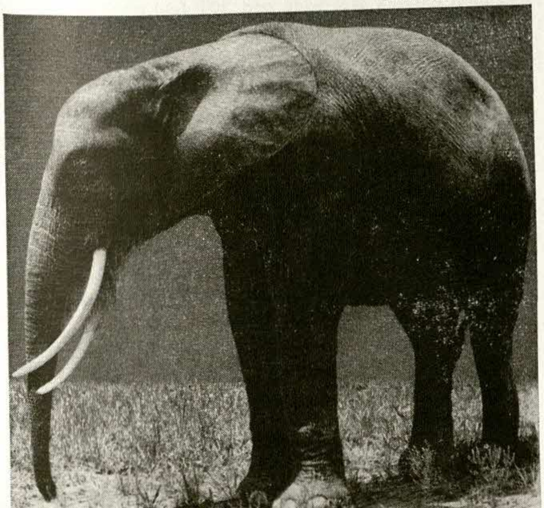
H. Armstrong Roberts

Feeding the Elephants is a favorite occupation at the zoo. Tame elephants are friendly and sometimes carry children on their backs.

needs less muscular power to stand because of its straight legs. For this reason an elephant can stand for very long periods of time without tiring. In fact, African elephants rarely lie down unless they are sick or wounded. Indian elephants lie down frequently.

The feet of an elephant are nearly round. African elephants have three nails on each hind foot, and four on each front foot. Indian elephants have four nails on each hind foot and five on each front foot. Beneath the bones of the foot is a tough, gelatinlike material that acts as a cushion or shock absorber. Under the elephant's weight the foot swells, but it gets smaller when the weight is removed. An elephant can sink deep into mud, but can pull its legs out readily because its feet become smaller when they are lifted.

The African Elephant is larger, stronger, and fiercer than the Indian elephant. Its huge ears measure at least 3½ feet across. A full-grown African elephant rarely lies down to sleep.
H. Armstrong Roberts



An elephant is a good swimmer and climber, but it can neither trot, run, jump, nor gallop. It has only one gait, a sort of gliding shuffle, which it can step up to the speed of a human sprinter. There are few animals that can travel farther in a day.

Skin. Elephants are called *pachyderms*, which means *thick-skinned* animals, and the name is well deserved. The gray hide of a big elephant—with hairs nearly an inch apart—will weigh a ton. It appears baggy and wrinkled as if it were too large for its owner. Most hunters believe that elephants see poorly and that they cannot distinguish a man beyond 80 yards. But their hearing is good, and no animal has a better nose. They depend more upon smell than on any other sense. The trunks of wild elephants are almost constantly sniffing.

Life of the Elephant

The mother elephant carries her young inside her body for 20 to 22 months, the longest known period of gestation of any animal (see GESTATION). She normally bears only one calf at a time, though twins are sometimes born. A female may have as many as eight calves in a lifetime. The calf stands about 3 feet high and weighs about 200 pounds. It nurses by curling its trunk over its head to reach the breasts that are between the mother's front legs. The mother carefully guards the calf against leopards, lions, and tigers. Usually she keeps it ahead of her and guides it by her trunk laid against its

Ylla, Rapho-Guillumette

An Indian Elephant Takes Orders from his *mahout,* a professional elephant driver, through signals. The animal responds to the pressure of the driver's foot behind his ears.

back. The young elephant is weaned at three or four years of age, and becomes fully grown at about 20. Elephants produce young—although rarely in captivity—at 14 or 15 years of age. They begin to show signs of old age at 40. Probably 60 years is as long as the average elephant can be expected to live.

Wild Elephants

Wild elephants live in herds of two hundred or more. These herds are made up of young and old of both sexes. They are led by either males or females, and appear to get along peaceably. During a march, they travel single file. To go down a slope, the elephant slides on its belly, extending its legs before and behind it. Male elephants sometimes become "bad" and very fierce. These bad elephants, called *rogues,* are driven out of the herd. Because male elephants often have uncertain dispositions, circuses usually use female elephants.

Men catch wild elephants in various ways. Sometimes deep pits are dug into which the elephants fall. The usual method, however, is to surround a herd with beaters and men on tame elephants. The beaters set up a great noise by shouting and blowing horns. The frightened herd is chased into a pen of heavy logs. A tame elephant is often placed in the pen to lure wild elephants inside. When the trapped animals have quieted down, men on trained elephants enter the pen, and rope each elephant securely until it is helpless. After a few days of hunger and thirst, the animals become tamer and ready for training.

Elephants That Work for Man

It takes much time, patience, and kindness to train an elephant. The elephant is taught to understand a few spoken commands, but is usually handled by signals. Pressure of the driver's foot behind the elephant's ear, or a shifting of the driver's weight, has a meaning for the elephant. Tame elephants can do immense amounts of work. A big one can drag several tons and lift, carry, and pile heavy logs. In India elephants are also much used for tiger hunting and for carrying tourists on pleasure trips. The advantage in using elephants for work is that they can work in dense forests where machines cannot be used. Their disadvantage is their enormous appetite. In one day a grown elephant can eat 200 pounds of food including rice, foliage, grass, and about 150 pounds of hay.

Superstitions About Elephants

Many people believe that elephants never forget an injury. It also is said that they are afraid of mice—particularly that mice will run up the inside of an elephant's trunk. There is a widespread belief that African elephants cannot be tamed. More common, perhaps, is the belief that elephants go to a graveyard to die.

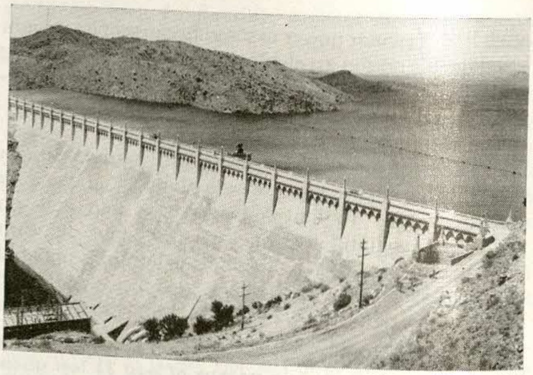
Elephants have good memories, but if they never forgot an injury it would be impossible to train them, for they are bound and starved when first captured. Zoo keepers say that elephants pay no attention to mice. And if a mouse ran into an elephant's trunk, he would be blown to "kingdom come." Jumbo, the "untamable African elephant," was ridden by thousands of American children, and, as for elephant graveyards, they have been much-sought but never found.

Scientific Classification. Elephants are the only survivors of the order *Proboscidea.* They make up the family *Elephantidae.* The Indian, or Asiatic, elephant is genus *Elephas,* species *maximus.* The African elephant is *Loxodonta africana.*

Roy L. Abbott

See also Animal (color picture, Africa); Circus (color pictures, The Circus Comes to Town, Under the Big Top); Mammoth; Mastodon.

ELEPHANT BUTTE DAM is part of the Rio Grande power and irrigation project near Truth or Consequences, N. Mex. The dam, which is of the concrete gravity type, is 301 feet high and 1,674 feet wide. It gets its name from a nearby mound, which is shaped like the head and back of an elephant. A road runs along the top of the dam, providing a bridge across the Rio Grande. Behind the dam is a reservoir 45 miles long and about 1¾ miles wide. It holds 2,185,400 acre-feet of water. The dam provides irrigation water to about 155,000 acres of land in New Mexico, Texas, and Mexico.



Bureau of Reclamation

Elephant Butte Dam runs across the Rio Grande in New Mexico. It is 1,674 feet wide and 301 feet high. The wall of the dam is 34 feet thick at the top and 154 feet at the bottom.

Elephant Butte Dam was authorized by Congress in 1907. It was completed in 1916 by engineers of the United States Reclamation Service. The Elephant Butte power plant was built in 1940. It has a capacity of 24,300 kilowatts. The Caballo Dam, about 25 miles downstream, adds to its power capacity.

T. W. Mermel

See also Dam.

ELEPHANT ROCKS. See Missouri (Interesting Places to Visit).

ELEPHANTIASIS, *EHL ee fan TY uh sis,* is a skin disease which is most common in the tropics. It gets its name because the skin of the affected part of the body becomes rough like the hide of an elephant. A tiny worm (*filaria*) usually causes the disease. Mosquitoes carry the worm. When the mosquito bites, the worm enters the body and becomes lodged in the lymph vessels. A less common form of elephantiasis is caused by the streptococcus bacterium.

Elephantiasis is characterized by fever, roughening of the skin, and ugly swelling of some part of the body, often the leg. There usually is a series of such attacks. Each attack leaves the part of the body more swollen than it was before. The swollen part finally becomes permanently enlarged. There is no known cure for elephantiasis, although drugs and surgery may give relief. Patients may live for many years. Leon H. Warren

See also Disease, Parasitic; Filaria; Mosquito (Other Diseases).

ELEPHANT'S-EAR is a plant with large leaves shaped like an elephant's ear or a shield. There are two common species. In the South Pacific, one type is eaten like potatoes. This type is also known as *taro, eddo, poi,* and *dasheen.* The ornamental elephant's-ear that grows in flower beds is very similar, but has a smaller root and a more beautiful leaf.

Scientific Classification. The elephant's-ear is in the arum family, *Araceae.* The ornamental form is genus *Colocasia,* species *antiquorum.* Marcus Maxon

See also Taro.

J. Horace McFarland

The Elephant's-Ear Plant gets its name from the leaves, which are shaped like a large ear or shield. A favorite Hawaiian dish is made by boiling the starchy roots of the plant.

ELEUSINIAN, *EHL you SIN ih un,* **MYSTERIES** were a religious rite carried out at Eleusis, near Athens, Greece. Worshipers purified themselves in the sea, then went in procession to Eleusis. They were forbidden to tell of the secret rite, which honored Demeter (Ceres), goddess of fruits and grains. The mysteries dramatized the loss of Demeter's daughter Persephone (Proserpina), and her return. Charlotte E. Goodfellow

See also Mysteries.

ELEUTHERA. See Bahamas.

Chicago Transit Authority

Three Elevated Trains Pass a Chicago Switch Tower.

ELEVATED RAILROAD, usually called an *El,* is an electric railroad that runs on tracks above the ground. The tracks are held up by strong steel beams or rest on an embankment. Elevated trains help make traffic less crowded on the ground.

The elevated car gets its power from a third rail which runs along the track. A powerhouse sends electric current down the third rail, and the elevated train picks it up with a metal plate, or *shoe,* which slides along the rail. The plate is connected to the motor, which turns the car wheels. The engineer who runs the train has a lever on his platform which controls the amount of current the motor can receive. With this lever the engineer starts and stops the train, and controls its speed.

Colonel Charles T. Harvey built a one-track experimental elevated line on the outskirts of New York in 1867. Dr. Rufus Gilbert developed the standard elevated structure used in New York and Chicago. The first cars were elaborate, with mahogany woodwork, carpeted floors, and plush seats. Carlton J. Corliss

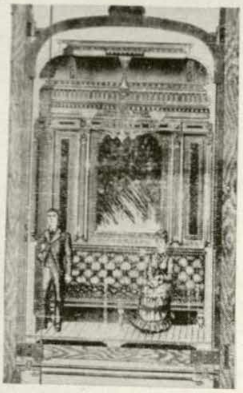
See also Electric Railroad.

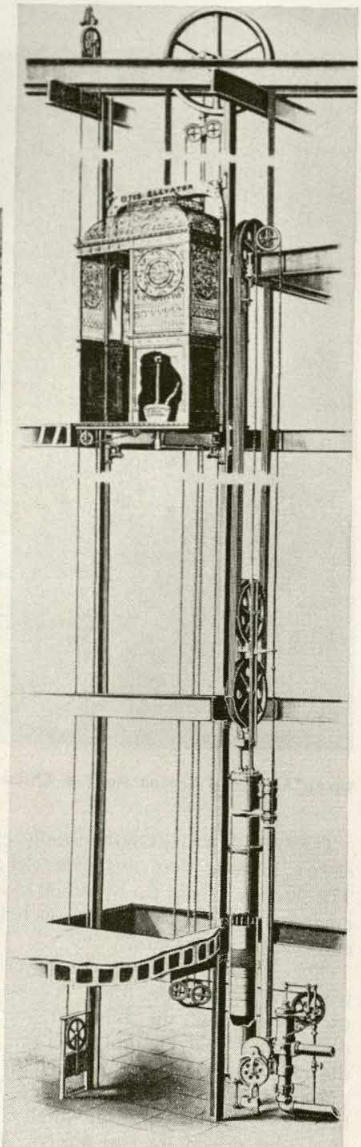
ELEVATION. See Bench Mark.

ELEVATION OF THE CROSS. See Rubens, Peter Paul.

ELEVATION OF THE HOST is the part of the Mass in the Roman Catholic Church in which the priest briefly holds aloft the consecrated wafer, or Host. It is followed by the elevation of the chalice (cup). The purpose of the ceremony is an act of faith in the presence of Christ on the altar. In its present form, the elevation of the Host dates from the 1200's. Fulton J. Sheen

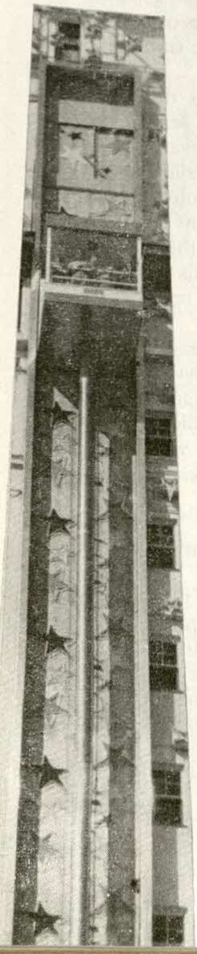
ELEVATOR, an airplane part. See Airplane (Tail Assembly).

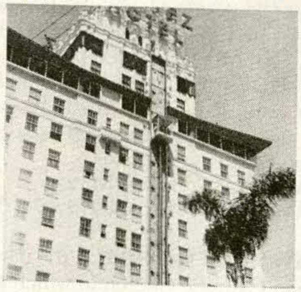




Hydraulic Elevator first used to carry passengers was installed in a 5-story building in New York City in 1857. It resembled an 1880 model, *right*. Department store elevators of the late 1800's were ornately furnished, *above*.

Otis Elevator Co.





An Outdoor Elevator, the "Star-Lift," carries passengers 200 feet up the outside wall to the roof of the El Cortez Hotel in San Diego, Calif. A steel hydraulic ram powers the glass elevator.

Glass Elevator, Inc.

ELEVATOR is a device that carries people and freight to different floors in buildings. The load is carried in a car, or cage, that runs up and down in an elevator shaft. The elevator shaft holds the car in place, and keeps it from moving from side to side. At each floor, the elevator shaft has a door that can be opened only from the inside. For the sake of safety, most elevators have a second door in the car for use in emergencies, when the regular door will not operate.

The elevator made possible the development of the modern skyscraper. Before there were elevators, people sometimes climbed several flights of stairs to reach their apartments or offices. But no worker today can be expected to make a daily climb to an office high in the 102-story Empire State Building or to the 43-story Chicago Board of Trade. Some persons install elevators in their homes, especially if an invalid or handicapped person lives there.

How an Elevator Works

A typical passenger elevator weighs about 30,000 pounds, not including the machinery that raises and lowers it. In addition, the car is capable of carrying about 3,500 pounds in passengers. Passenger elevator cars often contain such equipment as germ-killing lamps and an air conditioner for the comfort of the passengers, and a telephone for use in emergencies.

Controls. Some elevators are controlled by operators who ride inside the cars. The motor switch that starts and stops the elevator is connected to a box in the car. The operator moves a lever on the box to raise, lower, or stop the elevator.

Newer kinds of elevators work automatically and do not need an operator. They are widely used in apartment buildings and skyscrapers. Pressing a button outside the elevator shaft brings the elevator to the floor. The doors open automatically when the car reaches the floor. The passenger steps into the car and the doors close. He pushes another button inside the car to make it run to the floor he wants. The elevator stops automatically at the floor, the doors open, the passenger leaves, and the doors close again. In these elevators, each passenger can select a different floor, and the car will stop automatically at the desired floors in proper order. In some large buildings, the elevators are automatic, but an operator runs them by pushing buttons on the control panel in the car.

Elevators in busy buildings have electronic controls that keep the cars running on schedule and adjust their operation to meet traffic conditions. For example, these controls will adjust the operation of a group of cars to make them perform at peak efficiency during morning and evening rush hours.

The Cities Service Building in New York City uses double-deck elevators. The bottom deck stops at odd-numbered floors, and the upper deck stops at even-numbered floors. A ramp on the main floor makes it possible to reach either deck.

Machinery. Modern elevators run by electricity. The standard type of elevator used in tall buildings is called a *direct-traction elevator*. An electric motor placed at the top of the shaft raises and lowers the car. The motor shaft has a set of *sheaves*, or pulleys. Steel cables run from the top of the car, around the sheaves, and down to a heavy *counterweight*. The counterweight hangs at the back of the elevator shaft and balances the weight of the car. With a counterweight, the motor does not have to lift the entire weight of the elevator. It lifts only the difference between the weight of the loaded elevator and the counterweight. The counterweight moves in the opposite direction to the car. When the car goes up, the counterweight goes down. When the car goes down, the counterweight goes up.

Safety Features. For safety, the laws of most cities require two sets of doors, a stationary set in the walls at each landing and one on the car itself. These doors must both be closed before the elevator will move. Automatic protective devices make sure that the closing doors will not harm a passenger. Other safety devices include oil-cushion buffers at the bottom of the shaft. These protect against a fall. Electromagnetic brakes and automatic speed governors also provide safety.

History. Man has always tried to develop some simple method for lifting himself and his materials. One of the first elevators on record was invented by the Greek mathematician Archimedes about 253 B.C. His elevator was a hand-wound lift designed to carry a single passenger. The ancient Egyptians probably used some type of lift powered by slaves to construct the pyramids.

But it was not until men desired to build tall buildings that the demand for elevators really began. In the middle 1800's, there were many types of crude elevators that carried freight. Most of them ran hydraulically (see HYDRAULIC ENGINE). They could not lift much weight, and were extremely slow.

The first hydraulic elevators used a plunger below the car to raise or lower the elevator. A pump applied water pressure to a plunger, or steel column, inside a vertical cylinder. Increasing the pressure on the plunger raised the elevator. Releasing the pressure allowed the elevator to descend. The elevator also used a system of counterbalancing so that the plunger did not have to lift the entire weight of the elevator and its load. The plunger, however, was not practical for tall buildings, because it required a pit as deep below the building as the building was tall. Later, a rope-geared hydraulic elevator with multiple pulleys was developed.

In 1853, Elisha Graves Otis, of Yonkers, N.Y., invented the first hoist with an automatic safety device to keep the elevator platform from falling if the hoisting rope should break. Otis' machine was powered by steam. This was the beginning of the modern passenger or safety elevator. In 1857, Otis installed a five-story passenger elevator for a china and glass firm in New York City.

Other experimenters devised other types of elevators. In 1859, Otis Tufts of New York built and installed an elevator that was supported by a giant iron screw that ran vertically the entire length of the elevator shaft. The screw ran through the middle of the car. A steam engine in the basement turned the screw, which made the elevator rise or lower slowly.

Credit for installing the first electric elevator is generally given to Otis Brothers Company, which was operated by Elisha Otis' sons. The elevator was installed in a New York building in 1889, and lasted until the building was torn down in 1929.

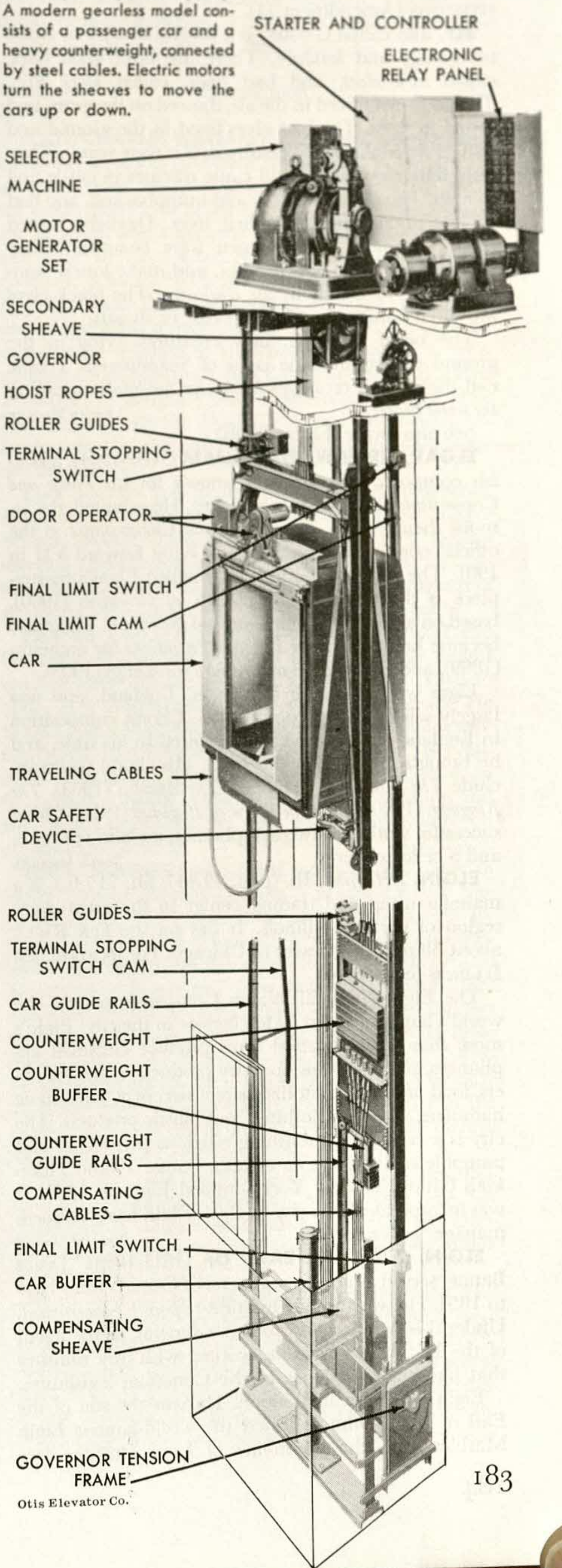
DONALD SHANNON

See also BUILDING AND WRECKING MACHINES (Materials Elevators); ELECTRIC MOTOR; ESCALATOR; SKYSCRAPER.

ELEVATOR, GRAIN. See GRAIN ELEVATOR.

HOW AN ELEVATOR WORKS

Electric Elevators carry millions of passengers every day. A modern gearless model consists of a passenger car and a heavy counterweight, connected by steel cables. Electric motors turn the sheaves to move the cars up or down.



Otis Elevator Co.

ELEVENTH AMENDMENT. See UNITED STATES CONSTITUTION (Amendment 11).

ELF, also called GNOME, is a dwarflike fairy in Norse mythology and folklore. There are both good ones, called *light elves*, and bad ones, called *black elves*. The good elves lived in the air, danced on the grass, and rested in trees. The bad elves lived in the ground and moved through earth as easily as if it were water. They were dangerous and could cause diseases in cattle and in men. The men were ugly and humpbacked, and had to live underground all their lives. Daylight turned them to stone. Their women were beautiful. They would often creep out at night, and make lonely wanderers lose their way in the darkness. The black elves are often confused with the *trolls*, or dwarfs.

The belief in small, ugly creatures living in the ground persists in some parts of Scandinavia. People call these small creatures *huldre*, or *huldufolk*, meaning *the secret people*.

EINAR HAUGEN

See also FAIRY (Elves; Trolls).

ELGAR, SIR EDWARD WILLIAM (1857-1934), a British composer, became best known for his *Pomp and Circumstance*, a set of five marches. He adapted the famous theme of the first *Pomp and Circumstance* as the official ode for the coronation of King Edward VII in 1901. The composition generally called Elgar's masterpiece is the oratorio, *The Dream of Gerontius* (1900), based on a poem by John Cardinal Newman. Elgar also became known for *The Enigma Variations* for orchestra (1899), and *Introduction and Allegro* for strings (1905).

Elgar was born near Worcester, England, and was largely self-taught in composition. Choral composition in England was somewhat uninspired in his time, and he brought new life to this form. His choral works include *The Black Knight* (1893), *The Apostles* (1903), *The Kingdom* (1906), and *The Spirit of England* (1916). Other successful works are two symphonies, a violin concerto, and a cello concerto.

JOYCE MICHELL

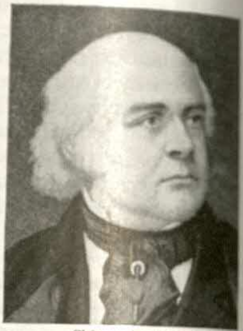
ELGIN, *EHL jihn*, Ill. (pop. 49,447; alt. 715 ft.), is a manufacturing and trading center in the great dairy region of northern Illinois. It lies on the Fox River, about 38 miles northwest of Chicago. For location, see ILLINOIS (color map).

The Elgin National Watch Company operates the world's largest jeweled watch factory in the city. Elgin's more than 120 industrial firms produce electrical appliances, paper cartons, foundry products, water softeners, food products, motorized street sweepers, pneumatic hammers, women's clothing, and plastic products. The city is a center for publishing religious periodicals and pamphlets. Elgin has an airport. James T. and Hezekiah Gifford of New York founded Elgin in 1835. It was incorporated as a city in 1854. Elgin has a council-manager government.

PAUL M. ANGLE

ELGIN, *EHL gihn*, **EARL OF** (1811-1863), JAMES BRUCE, served as governor-general of Canada from 1847 to 1854. He was the first to grant *responsible government*. Under this practice, the governor-general, as the agent of the British government, worked with any ministry that had the confidence of the Canadian legislature.

Elgin was born in London. He was the son of the Earl of Elgin, who collected the world-famous Elgin Marbles, and the son-in-law of Lord Durham (see DURHAM, EARL OF). He studied at Eton and at Oxford University, and entered the House of Commons in 1841. From 1842 to 1846, he served ably as governor of Jamaica. In Canada, too, his term was successful. He had troubles at first because of his approval of an act compensating French Canadians, who had rebelled, for their losses. Tory opposition arose against Elgin, and he was forced to move the seat of the Canadian government from Montreal to Ottawa.



Chicago Historical Society

The Earl of Elgin

After leaving Canada, Elgin served as a diplomat in Japan and China. In 1858, he negotiated the Treaty of Tientsin, easing trade restrictions within China. In 1862, he was appointed viceroy and governor-general of India.

JAMES L. GODFREY

ELGIN MARBLES are a group of splendid sculptures collected by Lord Elgin, mainly from the Acropolis at Athens. They include many sculptures from the Parthenon done under the direction of Phidias, the greatest Greek sculptor. Among these are the main figures from the gables, or *pediments*, 15 slabs from the *metopes*, or spaces above the columns, and 56 slabs from the famous frieze. The Elgin marbles also include one of the caryatids from the Temple of Nike.

In 1801, Lord Elgin, who was then British ambassador at Constantinople, received permission from the Turkish government to remove these sculptures. (Athens was then part of the Turkish Empire.) The first shipment was sent to England in 1803. The final pieces arrived there as late as 1812. Elgin sold the marbles to the British government in 1816 for an estimated $159,600. The government placed the sculptures in the British Museum in London.

FLORENCE HOPE

See also ACROPOLIS; BRITISH MUSEUM; PARTHENON.

Elgin Marbles in the British Museum are the remains of ancient Greek sculptures. The magnificent *metopes* from the Parthenon in Athens picture the struggle of mythical Greeks with centaurs.

Keystone

EL GRECO. See GRECO, EL.

ELI was an Israelite priest who lived soon after 1100 B.C. All that is known of him is told in I Samuel 1-4. He was chief priest at the temple in Shiloh, where Samuel was dedicated to a life of serving God. Samuel was given into the care of Eli. Eli's sons were priests, but the people despised their greedy ways and overbearing manners. The Philistines invaded and destroyed Shiloh and its temple, and Eli and most of his family were killed. Excavations by archaeologists reveal the destruction of Shiloh at this time. WALTER G. WILLIAMS

ELIJAH, *ee LI juh*, was a famous Israelite prophet of the 800's B.C. There are many interesting stories about him in the Bible from I Kings 17 to II Kings 2. He was born in Gilead.

Elijah opposed King Ahab, who allowed the heathen religion of Baal in Israel. In a contest on Mount Carmel with the priests of Baal, Elijah won the people to Israel's God. Elijah later denounced Ahab for stealing Naboth's vineyard. The Bible tells how a chariot of fire appeared to the prophet Elijah and carried him off to heaven in a whirlwind. WALTER G. WILLIAMS

See also AHAB; BAAL; ELISHA.

ELIMINATION is the process of throwing off waste and harmful substances from the body. The skin, lungs, kidneys, and lower intestinal tract carry out this function. The kidneys eliminate most of the excess water and salt. However, an average of about a pound and a half of water and a third of a teaspoonful of salt are eliminated through the skin every day. When visible sweating occurs, the elimination of water and salt by the skin may be much greater. Perspiration withdraws from the body about one fourth of the total amount of heat produced.

When a person breathes, he eliminates carbon dioxide and some water. An adult eliminates about 200 cc., or 6 ounces by volume, of carbon dioxide each minute.

Many different substances pass out of the body through the kidneys. They eliminate daily about a quart of urine, made up of water and certain solids. Urine contains the solid, *urea*, a waste product of the use of protein by the body. Another solid is salt, or sodium chloride. Elimination of certain acid salts, such as acid sodium phosphate, also takes place. Excess baking soda, or sodium bicarbonate, is sometimes eliminated in urine through the excretory system. The body rids itself of waste products of digestion through the colon, or large intestine. ANDREW CONWAY IVY

Related Articles in WORLD BOOK include:

Colon
Intestine
Kidney
Lung
Perspiration
Urea
Urine

ELIOT, CHARLES WILLIAM (1834-1926), an American educator, served as president of Harvard University for 40 years, from 1869 to 1909. He was one of the great university presidents of his time. He did much to shape the program and standards of liberal and professional education in the United States, and to establish the college as a major factor in the advancement of American life. Under Eliot's leadership, Harvard emerged as one of the great universities of the world. He brought outstanding scholars to the campus as teachers, reorganized the administration of the university, and added a number of graduate and professional colleges. The Law School and the Medical School became world-famous, and set the pattern for similar schools throughout the country.

Eliot actively led in improving secondary schools. He served as chairman of the Committee on Secondary School Studies (Committee of Ten), which recommended a more standardized and difficult course for high schools. This report helped shape the whole program of secondary education in the U.S. during the 1900's.

Eliot was born in Boston, and studied at Boston Latin Grammar School and Harvard University. He taught mathematics and chemistry at Harvard from 1858 to 1863, and then studied in Europe for two years. He taught at the Massachusetts Institute of Technology for four years, and then returned to Harvard as its president. Eliot was a member of the General Education Board and a trustee of the Rockefeller Foundation and the Carnegie Foundation. He also wrote widely on educational subjects. GALEN SAYLOR

ELIOT, GEORGE (1819-1880), was the pen name of MARY ANN (or MARIAN) EVANS, a British novelist. She published her first novel, *Adam Bede*, at the age of 40. Several of the book's characters were modeled on members of her family. In her next novel, *The Mill on the Floss* (1860), Maggie and Tom Tulliver represent Mary Ann and her brother. *Silas Marner* (1861) is her shortest and best-constructed novel. She is best known for these three novels. Her longest novel, *Middlemarch* (1871-1872), gives a picture of a whole community. Her only historical novel, *Romola* (1863), deals with Italy in the 1400's. Her other novels include *Felix Holt, the Radical* (1866) and *Daniel Deronda* (1876).

George Eliot regarded life and the spiritual development of her characters seriously. At the same time, her novels portray English farm folk with humor. She often wrote with a tenderness that indicated her own desire for love and sympathy.

Mary Ann Evans was born in Warwickshire. Her father, a plain, honest farmer, was agent for a large estate. She studied for several years at girls' schools. When she was 17, her mother died, and she was left to take charge of the family. She found time for much reading. At 30, she settled in London and became assistant editor of the *Westminster Review*. LIONEL STEVENSON

ELIOT, JOHN (1604-1690), was an American missionary to the Indians of Massachusetts. He came to America from England in 1631, and was made the teacher of the church in Roxbury, Mass. He organized his first village of Indian converts at Natick, near Boston, in 1651. By 1674, he had 14 villages with more than 1,000 Indians under his supervision. But King Philip's War in 1675 scattered his converts. Eliot was born in England. He translated the Bible into an Indian dialect. Earle E. Cairns

Chicago Historical Society

John Eliot, Pioneer Missionary, was the first minister to teach the Christian religion to the Indians of New England.

ELIOT, THOMAS STEARNS (1888-), became one of the most influential poets of his time. His views also gained wide effect through his works as an essayist and a playwright. Eliot was awarded the Nobel prize for literature in 1948 for his work in modern poetry.

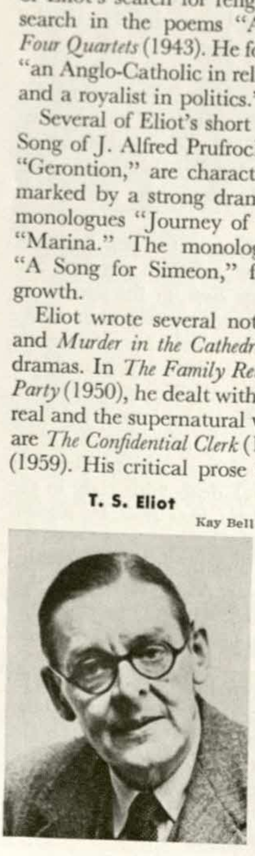
Eliot's famous poem, *The Waste Land*, appeared in his own new magazine, *The Criterion*, in England in 1922. This poem was partly a description of postwar disillusionment, but was later seen to be the beginning of Eliot's search for religious faith. He continued this search in the poems "Ash Wednesday" (1930) and *Four Quartets* (1943). He found his solution by becoming "an Anglo-Catholic in religion, a classicist in literature, and a royalist in politics."

Several of Eliot's short poems, including "The Love Song of J. Alfred Prufrock," "The Hollow Men," and "Gerontion," are character portraits. These works are marked by a strong dramatic sense, as are the poetic monologues "Journey of the Magi," "Coriolan," and "Marina." The monologues, along with the poem "A Song for Simeon," further trace Eliot's religious growth.

Eliot wrote several notable plays. *The Rock* (1934) and *Murder in the Cathedral* (1935) are religious poetic dramas. In *The Family Reunion* (1939) and *The Cocktail Party* (1950), he dealt with the relationship between the real and the supernatural worlds. Among his later plays are *The Confidential Clerk* (1954) and *The Elder Statesman* (1959). His critical prose includes the book *On Poetry and Poets* (1957).

T. S. Eliot

Kay Bell



Eliot was born in St. Louis. He received his undergraduate degree from Harvard University in three years, then took a master's degree in his fourth year. He also studied at the Sorbonne in France, at Oxford University, and in Germany. He wrote a Ph.D. dissertation at Harvard, but did not take a degree. In 1927, Eliot became a British citizen. John Holmes

ELISHA, *ee LIE shuh*, was the follower, servant, and later the successor of Elijah. He carried on his master's policies against the pagan religion favored by King Jehoram. With this purpose he encouraged Jehu to rebel and seize the throne. Many striking stories are told about him in II Kings 2-9. See also Elijah; Jehu.

ELISION, *ee LIZH un*, means dropping or slurring a sound or syllable in poetry to keep a rhythmic pattern or to create an effect. Milton, in *Paradise Lost*, wrote

> Now to th'ascent of that steep savage hill
> Satan had journeyed on, . . .

The elision helps to suggest the effort of climbing. In the *Ancient Mariner*, Samuel Taylor Coleridge wrote

> We drifted o'er the harbor-bar . . .

The *r* sound of *o'er*, an accented syllable, is emphasized and echoed in *har* and *bar*. Without the elisions, the tone of these lines would have changed. M. L. Rosenthal

ELISSA, another name for Dido. See Dido.

ELIXIR, *ee LIHK sur*, is a fragrant, sweetened, alcoholic preparation. It is used to disguise the taste of medicines. People occasionally misuse elixir because of its alcoholic content. In the Middle Ages, the early chemists, or alchemists, gave the name *elixir* to a mythical substance. This substance supposedly changed the baser metals into silver or gold, restored youth, and lengthened life. Elixir also refers to the purest part of a thing. This explains the meaning of the words from Bayard Taylor's *Lands of the Saracen:* "The air we breathed was an elixir of immortality." See also Alchemy. Austin Edward Smith

ELIZABETH, N.J. (pop. 107,698; alt. 21 ft.), is the oldest English settlement in the state. The city lies in the eastern part of New Jersey, 12 miles southwest of New York City. For location, see New Jersey (color map).

Elizabeth has been the home of the Singer Sewing Machine Company since 1873. Other important products include beverages, chemicals, clothing, industrial machinery, and iron and steel products.

Elizabeth was settled in 1664 after England gained control of the Dutch colonies in North America. Philip Carteret (1639-1682), first English governor of New Jersey, selected the settlement as the site for his capital. He called it *Elizabethtown*. The city's industrial development began after 1835 when a group of New York businessmen bought land bordering Staten Island Sound, on which to build manufacturing plants. Elizabeth also became an important railway center. The Goethals Bridge, which connects Elizabeth with Staten Island, opened in 1928. Elizabeth has a mayor-council type of government. Richard P. McCormick

ELIZABETH, EMPRESS OF AUSTRIA. See Francis Joseph.

ELIZABETH, QUEEN MOTHER OF ENGLAND. See George (VI) of England.

ELIZABETH, QUEEN OF THE BELGIANS. See Albert I.

ELIZABETH, SAINT, was the mother of John the Baptist. St. Luke says (Luke 1:5-45) that she was a kinswoman of the Virgin Mary. When both Elizabeth and her husband, Zacharias, were advanced in years, the angel Gabriel appeared to Zacharias and predicted that his wife would bear a son to be called John. Mary visited her at her home in the hill country of Judea before the birth of Jesus. St. Elizabeth's feast day is November 5. Fulton J. Sheen and Merrill C. Tenney

See also John the Baptist.

Queen Elizabeth crossed a muddy spot in a Greenwich street on the cloak of Sir Walter Raleigh. Sir Walter Scott repeats this old legend in his famous novel, *Kenilworth*.

Culver

Brown Bros.

Queen Elizabeth I was often called "Good Queen Bess."

ELIZABETH I (1533-1603) was Queen of England from 1558 to 1603, one of the most glorious periods in English history.

Born in London, Elizabeth was the daughter of King Henry VIII and Anne Boleyn. When her mother lost favor with the king and was beheaded, Elizabeth, aged 3, was declared illegitimate. But she was later given her place in the succession to the throne. When her half-sister, Mary, a Roman Catholic, became queen, she was suspicious of Elizabeth, the Protestant heir to the throne. For a time, Elizabeth's life was in grave danger.

Problems of Her Reign. When Mary died in 1558, she left Elizabeth with many serious problems. These included a war with France, a bankrupt treasury, and above all, the question of England's religion. Elizabeth ended the war, and placed English finances on a sound basis. She then tried to find a solution to the religious question that would satisfy the majority of her subjects. She re-established the Anglican Church, freeing it from Roman Catholic control. But the Church was not extremely Protestant. Her chief adviser in these moves was Sir William Cecil, later Lord Burghley.

Elizabeth's first parliament questioned her about marriage. They were afraid that, if she died, her nearest relative, Mary Stuart, Queen of Scots, would become queen. But Elizabeth took her time. She kept her foreign suitors, among them Philip II of Spain and the French Duke of Anjou, waiting a long time for an answer. In the end, she remained single.

Mary, Queen of Scots. Because Mary, the Scottish queen, was a Roman Catholic and an extremely ambitious and unscrupulous woman, a series of plots centered around her throughout much of Elizabeth's reign. In 1587, Mary was accused of participating in a plot against Elizabeth's life. Elizabeth finally, though reluctantly, consented to Mary's execution and to sterner measures against the Roman Catholics. Elizabeth's reluctance did not save her from the wrath of Philip II of Spain, the ruler of the most powerful state in Europe. He sent the great Armada against England. But the superior seamanship of the English sailors, and storms in the North Sea, destroyed the Spanish fleet. See ARMADA; MARY, QUEEN OF SCOTS.

The Golden Age. The removal of Mary as a center of discontent and the tremendous victory over the Spanish fleet brought a feeling of self-confidence and pride to England that the country had never known before. Elizabeth herself became a living legend, the ageless "Virgin Queen," the "Gloriana" of Edmund Spenser, or, to the majority of her subjects, simply "Good Queen Bess." During these years, Shakespeare wrote his plays, Spenser wrote *The Faerie Queene*, and Sir Francis Bacon, his *Essays* (see ENGLISH LITERATURE [The Tudor Period]). But the Elizabethan Englishman was even more a man of action than of words. Daring sailors like Sir Francis Drake, Sir Martin Frobisher, and Sir Walter Raleigh roamed the seas in search of new lands and wealth. England's future colonial empire was begun in these years.

Her Character. Elizabeth remains a puzzling figure. She was vain and deceitful and, despite the achievements of her reign, largely unmoved by religious feeling or literary masterpieces. But she managed to gain and hold the love of her subjects to the end of her long life. They recognized that she had made England's well-being the chief aim of her life. W. M. SOUTHGATE

See also CLOTHING (color picture, Western Europe); FURNITURE (English); HENRY (VIII).

ELIZABETH II (1926-   ) is the Queen of Great Britain and the head of the British Commonwealth of Nations. She became queen at the age of 25 on the death of her father, George VI, on Feb. 6, 1952.

Early Years. Elizabeth was born in London on April 21, 1926, when her parents were the Duke and Duchess of York. Her mother was Lady Elizabeth Bowes-Lyon, daughter of the Earl of Strathmore, of an ancient Scottish family. Elizabeth was then third in succession to the throne. Her father became King George VI in 1936, after his brother, Edward VIII, abdicated. So, at the age of 11, Elizabeth became heiress to the throne. Under the supervision of her grandmother, Queen Mother Mary, Elizabeth was trained from early childhood for the royal duties she would some day assume. The princess was affectionately known as "Lilibet."

During World War II, Elizabeth served in the Auxiliary Territorial Service. She became the fourth woman to be given the Order of the Garter, the highest order of British knighthood. In 1947, she accompanied her parents on a tour of the Union of South Africa. She celebrated her 21st birthday on this trip by announcing to the British people by radio that ". . . my whole life, whether it be long or short, shall be devoted to your service, and to the service of our great imperial family."

The Royal Family. Elizabeth married Philip Mountbatten, formerly Prince Philip of Greece, on Nov. 20, 1947, in Westminster Abbey. King George gave Philip the title Duke of Edinburgh on the same day. Their first son, Charles Philip Arthur George, was born in 1948; a daughter, Anne Elizabeth Alice Louise, in 1950; and their second son, Andrew Albert Christian Edward, in 1960. Prince Charles became heir apparent when his mother became queen. Philip was made a prince in 1957. The royal family's name is Windsor, but Queen Elizabeth announced in 1960 that her descendants will bear the name Mountbatten-Windsor.

The Royal Tours. After 1948, when King George's health began to fail, Elizabeth and Philip assumed many of the royal obligations. They made an extended tour of Canada in 1951, and visited Washington, D.C. Early in 1952, they began what was to be a round-the-world tour of British colonies and the dominions of Ceylon, Australia, and New Zealand. But while in Kenya, Africa, they heard that George VI had died. Elizabeth returned to England at once. On Feb. 8, 1952, she was proclaimed "by the Grace of God, Queen of this realm and of her other realms and territories, head of the Commonwealth, Defender of the Faith." Coronation ceremonies were held on June 2, 1953, in Westminster Abbey.

The following November, Queen Elizabeth II and her husband set out again on their tour of the Commonwealth nations. On this trip, they visited Bermuda, Jamaica, the Republic of Panama, the Fiji Islands, the Tonga Islands, New Zealand, Australia, Ceylon, Aden, Uganda, Malta, and Gibraltar. They returned to London in May, 1954, after traveling 44,210 miles. In January and February, 1956, the queen and Philip visited Nigeria.

In April, 1957, Queen Elizabeth paid a state visit to Paris. She visited Canada and the United States in October, 1957. In Canada she opened the new session of parliament, the first reigning sovereign to do so. She emphasized the position of the royal family in the British Commonwealth by speaking as "Queen of Canada." In the United States, she visited Washington, D.C., Williamsburg, Va., and New York City. She returned to Canada in 1959 to attend the opening of the Saint Lawrence Seaway at Quebec. She also paid official visits to almost all parts of the kingdom.

The Queen at Home is a keen horsewoman. She keeps race horses, and frequently attends races. She favors simplicity in court life. After the 1958 season, the queen discontinued formal presentation parties for debutantes. Scholars, artists, critics, and authors have attended informal parties with her.

C. L. MOWAT

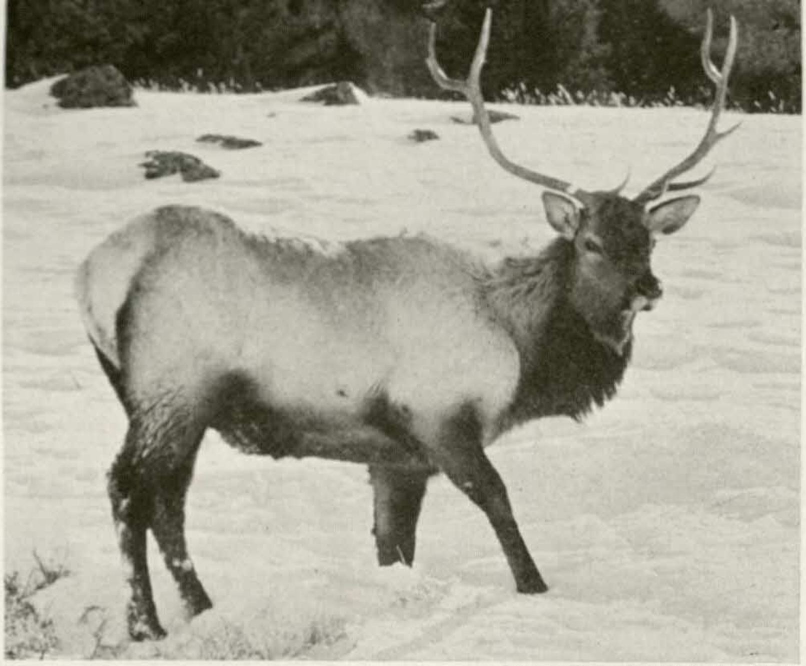
See also CHARLES, PRINCE; CORONATION (pictures); GREAT BRITAIN (Elizabeth II; picture, The Coronation); PHILIP, PRINCE; WINDSOR.

◀ **Queen Elizabeth II** was crowned with the jewel-encrusted Imperial Crown of State in June, 1953. Emblems of the Commonwealth countries, embroidered in gold, silver, pearls, and silk, decorate her white gown.

Cecil Beaton, Wide World

The Queen's Family includes her husband, Prince Philip, and their three children. Prince Charles, the heir apparent to the throne, and Princess Anne admire their brother, Prince Andrew, born in 1960.

Camera Press-Pix



American Elk spend the winter in low mountain valleys where the snow is not too deep. In spring, they move back into higher mountains. The adult bull grows rounded antlers which may spread to five feet and have 12 or more points.

Joe van Wormer, National Audubon Society

ELIZABETH CITY STATE TEACHERS COLLEGE is a state-controlled coeducational college at Elizabeth City, N.C. It offers courses leading to a B.S. degree in education. The school was founded in 1891. For enrollment, see Universities and Colleges (table).

ELIZABETHAN AGE was named for Elizabeth I, Queen of England, who ruled from 1558 to 1603. The age was a time of many great achievements, reflecting the spirit of the Renaissance as it affected England.

The English people supported the queen's strong government with enthusiasm. They produced the ships and men to defeat the Spanish Armada, and started England's career as Mistress of the Seas. The daring successes of Elizabeth's "sea dogs" were matched by the achievements of William Shakespeare and other dramatists, and by the works of great poets, musicians, and scholars. The Elizabethan Age stands with three other great creative periods: the Age of Pericles in Greece, the Age of Augustus in Rome, and the Age of Louis XIV in France. Paul M. Kendall

See also Elizabeth I; English Literature (The Tudor Period).

ELIZABETHTOWN, Ky. See Kentucky (Interesting Places to Visit).

ELIZABETHTOWN COLLEGE at Elizabethtown, Pa., is a coeducational liberal arts college. It is connected with the Church of the Brethren. Courses lead to B.A. and B.S. degrees. The college was founded in 1899. For enrollment, see Universities and Colleges (table).

ELIZA'S COTTAGE. See Ontario (Interesting Places to Visit).

ELK is the name of two different members of the deer family. One is found in North America. The other lives in Europe and looks like the American moose.

The American Elk. The Shawnee Indians and the scientists of later times called the American elk the *wapiti*. The animal was given the name of *elk* by the early English colonists. They paid no attention to the fact that the name *elk* had long been used for the European moose. Nevertheless, the name stuck, and is still most commonly used. The American elk is a close relative of the red deer of Europe and Asia. It is smaller than the European elk (European moose). The *bull*, or male, elk stands about 5 feet high at the shoulder, and may weigh from 700 to 1,000 pounds. Its rounded antlers may spread as much as 5 feet. Those of a grown bull will have a total of about 12 points. Antlers grow during the summer months and are shed in late winter. The cow, or female, is smaller than the male, and has no antlers. Elk are brownish-gray with a yellowish-tan rump. The legs, head, and maned neck of the elk are dark brown.

During September and October the bulls fight for leadership in the herd. An exceptional bull may keep a harem of 60 or more cows, but the average one keeps only a dozen or so at a time. As the elk travel from high mountain valleys called parks to the lower valleys, they gather into large herds of both sexes and all ages. Here, where the snow is not too deep, they spend the winter. Spring finds them moving slowly back into the higher mountains. The calves are born in May or June. Only rarely does a cow bear more than one. The calf is light tawny-brown with numerous white spots. These spots are lost during the first change of coat in August.

Most of the food of elk is grasses. They also eat the twigs and needles of fir, juniper, and many hardwood trees and shrubs, especially during the winter. Unfortunately, many of the larger elk herds of the United States and western Canada do not have enough winter range for feeding. Many animals die of starvation or from diseases such as pneumonia and *necrotic stomatitis*, or "calf diphtheria." Wolves and cougars are among the natural enemies of elk. Bears and coyotes kill some calves and sick or crippled adults.

Elk were once found over most of the United States and southern Canada. They have been killed off from many of these places, and survived only in the region between the eastern Rockies and the Pacific Coast. They have been reintroduced in small numbers to several regions. These include parts of Pennsylvania, Virginia, Michigan, South Dakota, New Mexico, and Arizona. The largest herds live in Yellowstone Park, on Montana's Sun River, and in Washington's Olympic Mountains.

The European Elk. This largest European deer is much like the huge awkward American moose, with its scoop-shaped antlers. During the Middle Ages it was sometimes used as a beast of burden in Scandinavia. But the reindeer took its place later. The elk has been well protected by law in European countries, but apparently it is gradually dying out. Some elk still exist in forests of Norway, Sweden, Russia, and Germany.

Another species of deer, known as the *Irish elk*, is extinct. It probably belonged to the fallow deer family. This elk was immense and distinguished by its enormous antlers, sometimes 11 feet from tip to tip.

The Altai wapiti and Manchurian wapiti of Asia are the largest of all the red deer. But they do not have such huge antlers as the wapiti of America.

Scientific Classification. Elk belong to the family *Cervidae*. The American elk is genus *Cervus*, species *canadensis;* the European is *Alces alces*. VICTOR H. CAHALANE

See also ANIMAL (color picture, North America); DEER; MOOSE; RED DEER; REINDEER.

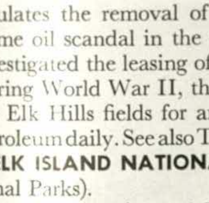
ELK HILLS is a United States naval petroleum reserve of 46,000 acres in the southern part of the Great Valley of California. These oil lands lie in a hot, flat region in Kern County, near Bakersfield. The reserve holds about a quarter of the known oil on the West Coast. The navy regulates the removal of the oil. During the Teapot Dome oil scandal in the early 1920's, the government investigated the leasing of the fields to private interests. During World War II, the United States Navy tapped the Elk Hills fields for an output of 65,000 barrels of petroleum daily. See also TEAPOT DOME. C. LANGDON WHITE

ELK ISLAND NATIONAL PARK. See CANADA (National Parks).

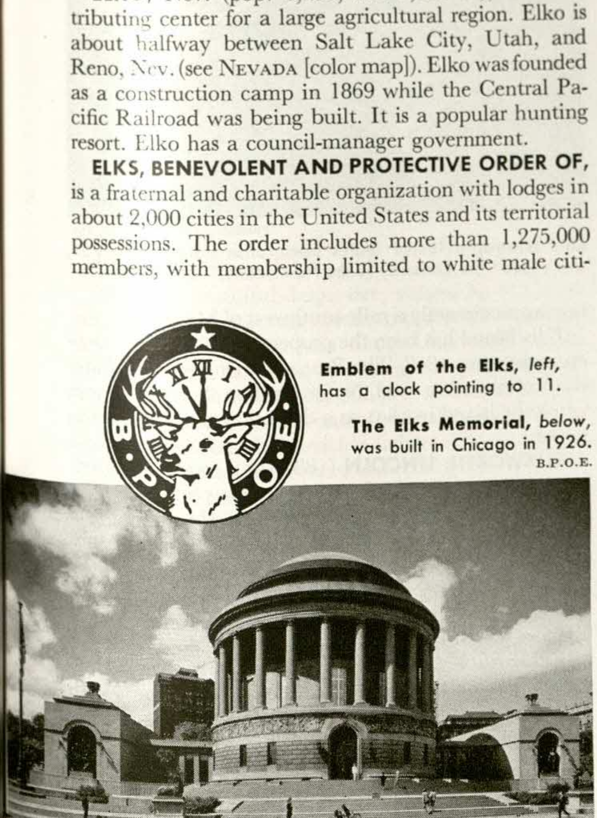
ELKO, Nev. (pop. 6,298; alt. 5,060 ft.), is a distributing center for a large agricultural region. Elko is about halfway between Salt Lake City, Utah, and Reno, Nev. (see NEVADA [color map]). Elko was founded as a construction camp in 1869 while the Central Pacific Railroad was being built. It is a popular hunting resort. Elko has a council-manager government.

ELKS, BENEVOLENT AND PROTECTIVE ORDER OF, is a fraternal and charitable organization with lodges in about 2,000 cities in the United States and its territorial possessions. The order includes more than 1,275,000 members, with membership limited to white male citizens of the United States who are over 21 years of age and of good moral character.

The organization contributes millions of dollars each year to charitable causes. The national organization supports the Elks National Foundation Fund. It uses this fund for such projects as scholarships, crippled children's work, and the care of tubercular patients. The Order of Elks maintains a home for aged members in Bedford, Va. The Elks headquarters are in the Elks Memorial at 2750 Lakeview Ave., Chicago 14, Ill. The memorial honors Elks who served in World Wars I and II. L. A. DONALDSON



Emblem of the Elks, *left,* has a clock pointing to 11.



The Elks Memorial, *below,* was built in Chicago in 1926.

B.P.O.E.

ELL is a measure of length taken from the forearm. The word comes from an Anglo-Saxon word, *eln*, or the Teutonic *alina*, which means the forearm from the tip of the middle finger to the elbow. The word *elbow* also comes from one of these words. The English ell was 45 inches, and the Scottish was 37. The Flemish ell measured three quarters of a yard. The French ell is 1.20 meters, or about a yard and a third. E. G. STRAUS

ELLENDER, ALLEN JOSEPH. See LOUISIANA (Famous Louisianians).

ELLERY, WILLIAM (1727-1820), one of the Rhode Island signers of the Declaration of Independence, served in the Continental Congress from 1776 to 1781 and from 1783 to 1785. Congress appointed him commissioner of the Continental Loan Office for Rhode Island in 1786. He served as collector of customs for Newport from 1790 until his death. Ellery was born in Newport, and served as naval officer of Newport from 1754 until he turned to law in 1770. RICHARD B. MORRIS

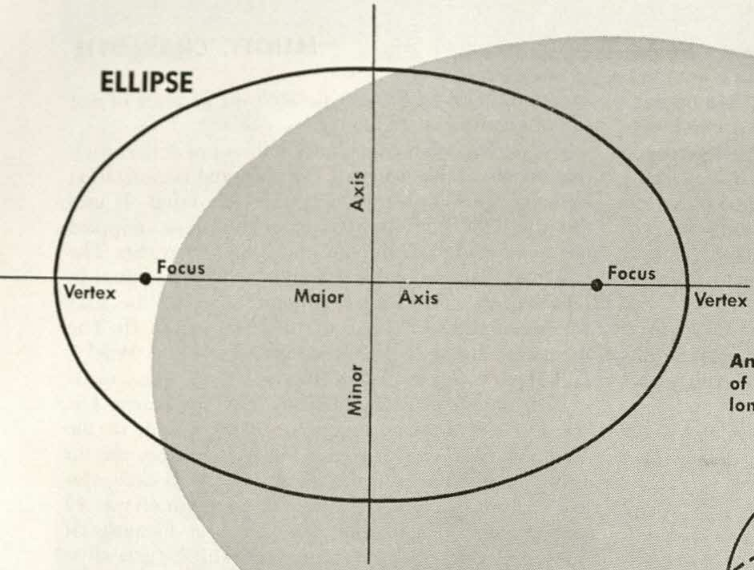
ELLESMERE ISLAND, *ELZ meer*, is an uninhabited, ice-covered isle which lies west of northern Greenland. It covers 82,119 square miles and ranks as the world's ninth largest island. Smith Sound and Kennedy Channel separate it from Greenland. The Prince of Wales Mountains rise in eastern Ellesmere. Arthur and Grinnel islands lie north of Ellesmere. William Baffin discovered Ellesmere in 1616, and Robert Peary explored the island in 1899. It is part of the Canadian Northwest Territories. See also ARCTIC OCEAN (map); BAFFIN, WILLIAM; PEARY, ROBERT EDWIN. BOSTWICK H. KETCHUM

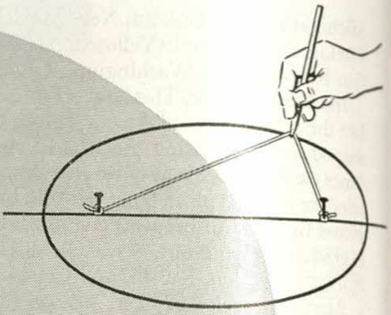
ELLICE ISLANDS, *EHL ihs*, consist of nine coral islands in the South Pacific with an area of about 10 square miles. Coconut palms and pandanus plants cover the islands. A British protectorate from 1892 to 1915, the islands then became part of the British-owned Gilbert and Ellice Islands Colony. Though closely associated with the Gilbert Islands, the people of the Ellice group differ from those of the Gilberts. They have light skins, resemble Samoans, and speak the Samoan language. Gilbert Islanders are smaller and darker, and speak a Micronesian language. Japanese forces occupied the Ellice Islands early in World War II. American forces liberated the islands in 1943, and set up a base on Funafuti. This atoll has a hospital and government headquarters. Population of the islands is about 4,500. See also PACIFIC ISLANDS. EDWIN H. BRYAN, JR.

ELLINGTON, "DUKE," EDWARD K. See JAZZ (Famous Jazz Musicians).

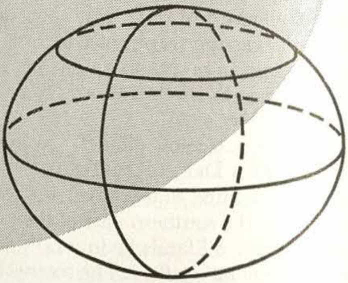
ELLIOT-MURRAY-KYNYNMOND, GILBERT JOHN. See MINTO, EARL OF.

ELLIOTT, CHARLOTTE. See HYMN.





An Ellipse Can Be Drawn by pinning the ends of a string at the two foci. The string must be longer than the distance between the two foci.



The Plane Sections of an Ellipsoid are circles or ellipses. An ellipsoid is a solid, three-dimensional figure. Astronomers and geologists use this figure to describe the shape of the surfaces of the earth and other planets.

ELLIPSE, *eh LIHPS,* is a geometrical figure with the shape of a flattened hoop. In geometrical terms, an ellipse is one of the conic sections (see CONE). It is drawn with an *ellipsograph,* or elliptic compass.

But the simplest method is to fasten the ends of a string at two points, called the *foci* (see the drawings above). The string must be longer than the distance between the foci. Hold a pencil upright against the string so that the string is stretched tight at all times. Draw half the ellipse; then lift the pencil and move the string to the other side of the pins to draw the second half. The diameter passing through the foci is called the *major axis.* The diameter running perpendicular, or at right angles, to the major axis is the *minor axis.*

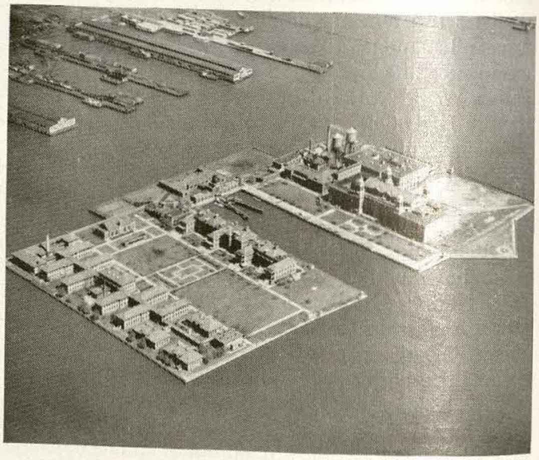
To find the area of an ellipse, multiply half the length of the major axis by half that of the minor axis. Multiply the result by *pi,* or 3.14, which represents the ratio of the circumference to the diameter. In the drawing above, the major axis might be 64 feet and the minor axis might be 48 feet. One half of 64=32; one half of 48=24; 32x24=768; 768x3.14=2411.52, the area in square feet.

HARRY C. BARBER

ELLIS, HAVELOCK (1859-1939), was a British author and psychologist. He qualified as a physician, but devoted himself to psychology. In his seven-volume *Studies in the Psychology of Sex* (1897-1928), Ellis tried to be both scientific and aesthetic in his approach to psychology. The *World of Dreams* (1911) is a psychoanalytic study of his own dreams. He also wrote *The Philosophy of Conflict and Other Essays* (1919) and *The Dance of Life* (1923). Ellis was born at Croydon, Surrey.

WALTER WRIGHT

ELLIS ISLAND was a United States immigration station for more than 60 years. During that time, officials examined more than 20,000,000 aliens at the island. In 1954, the government ended its activities at the station. Most immigrants now are cleared for entry before they come to this country. The island lies in New York harbor, approximately a mile southwest of Manhattan.



Fairchild Aerial Surveys, Inc.

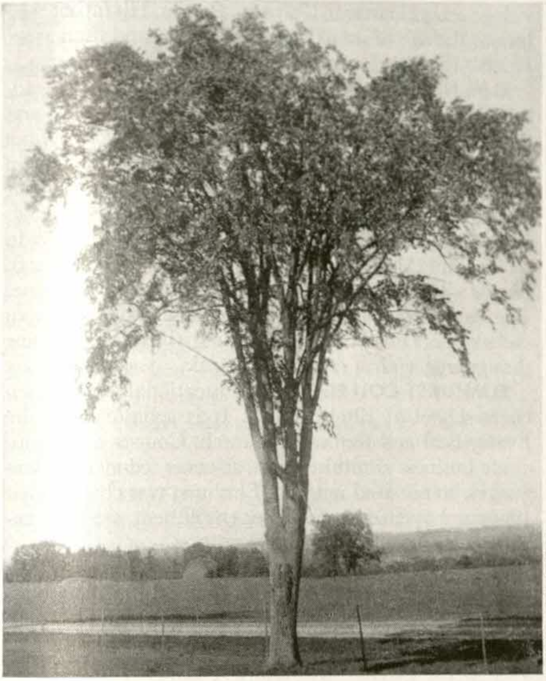
Ellis Island, a United States immigration station until 1954, was called "The Gateway to the New World."

Ellis Island has been the property of the Federal Government since 1808. The Bureau of Immigration (later the Immigration and Naturalization Service) began using the island in 1891 as a detention and deportation center.

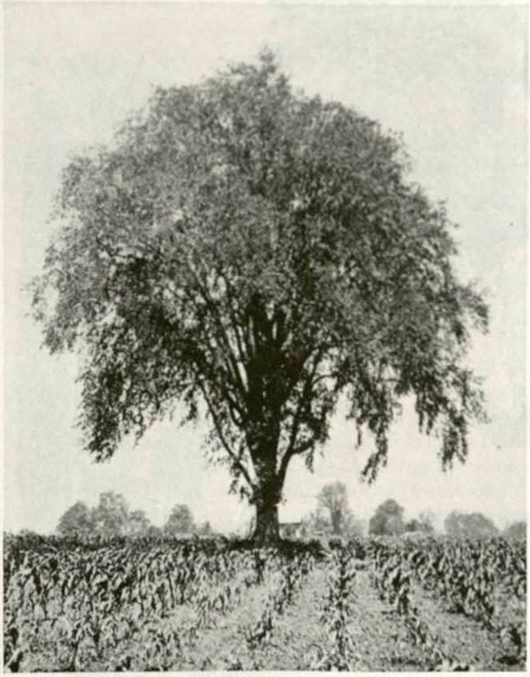
WILLIAM E. YOUNG

ELLSWORTH, LINCOLN (1880-1951), was an American civil engineer and explorer who participated in many scientific and polar expeditions. He worked as a mining engineer in Alaska and served as a field assistant with the United States Biological Survey. In 1924, he led a geological survey of the Andes Mountains. With Roald Amundsen, he made the first aerial crossing of the vast North Polar Basin.

Ellsworth was co-leader in 1926 of the Amundsen-Ellsworth-Nobile Transpolar Flight across the North



American Elms have two distinctive shapes. Some American elms grow in the form of a vase, *left.* In these elms, the trunk separates into large limbs, most of which extend straight up.



L. W. Brownell; V. H. Van Ries, *Nature* Magazine

Other American elms grow in the form of an umbrella, *right.* People often plant these elms as shade trees. The branches grow upward at a slight angle and spread out at the top.

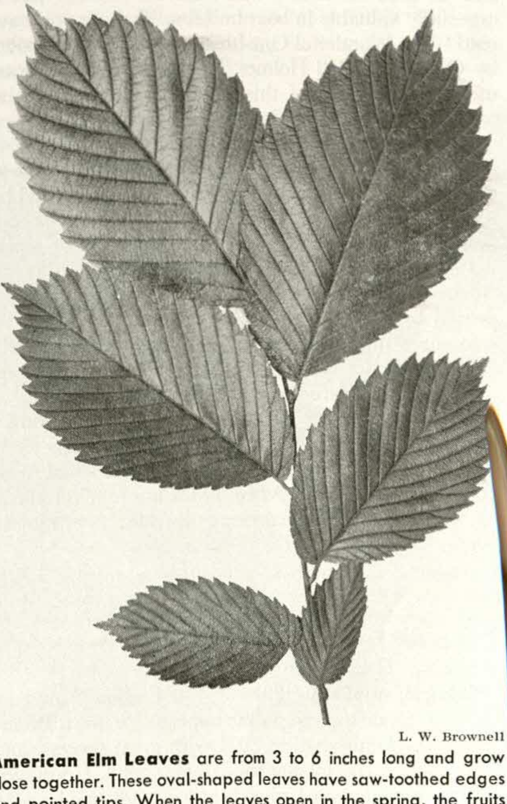
Pole. He participated in the *Graf Zeppelin* dirigible flight to the Arctic in 1931. In 1935, he and his pilot became the first to fly across Antarctica. They claimed large new territories for the United States (see ANTARCTICA). Ellsworth was born in Chicago, and studied at Columbia and Yale universities. His books include *Search* (1932) and *Beyond Horizons* (1938). ROBERT W. ABBETT

ELLSWORTH, OLIVER (1745-1807), was Chief Justice of the United States from 1796 to 1799. A noted lawyer, Ellsworth served in the Continental Congress, and was a delegate to the Constitutional Convention of 1787. He was a Federalist United States Senator from 1789 to 1796, and played the major role in drafting the important Judiciary Act of 1789. This act established the federal court structure. Much of its substance is still in effect. He was born in Windsor, Conn. JERRE S. WILLIAMS

ELM is a beautiful, large tree, valued for its lumber and shade. Elm trees are common in Europe and America. They also grow in Asia. Some American elms have the shape of a tall vase, spreading out gradually from the bottom. In others, the limbs branch out from the top of a tall trunk in the form of an umbrella or a feather duster. Elm trees often reach a height of 75 to 100 feet. Some elm trees live for more than 200 years.

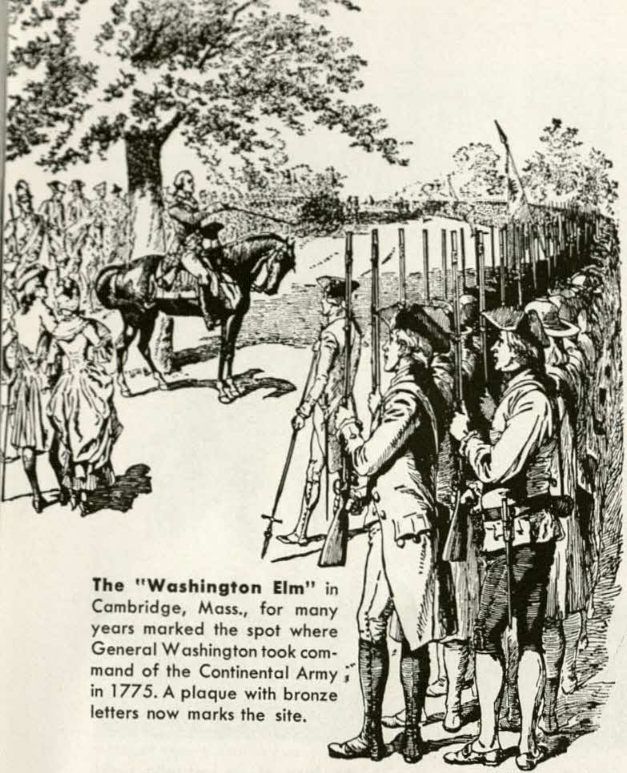
The small greenish flowers of the American elm appear in the spring, long before the leaves grow. The fruits, each with a little wing around it, sail down to the ground as the leaves open. The leaves are oval. We know that the elm is the favorite home of orioles, for in the winter we can see their deserted nests swinging in its bare branches.

Elm wood is tough and hard, and light brown in color. Since it does not split easily, it is useful for making



L. W. Brownell

American Elm Leaves are from 3 to 6 inches long and grow close together. These oval-shaped leaves have saw-toothed edges and pointed tips. When the leaves open in the spring, the fruits of the tree fall to the ground.



The "Washington Elm" in Cambridge, Mass., for many years marked the spot where General Washington took command of the Continental Army in 1775. A plaque with bronze letters now marks the site.

Bettmann Archive

barrels, wagon wheels, and farm implements, and may also be used for fuel. Wood from the *rock elm* tree is especially valuable in boat building. Perhaps you have read "The Wonderful One-hoss Shay," a famous poem by Oliver Wendell Holmes. Rock elm was the wood used for the hubs of this carriage. The tree is also called *cork elm* because its bark is very corky.

The *slippery elm* has a gluey inner bark which boys like to chew. The pioneers used the same inner bark to treat sore throat. This kind of elm can be recognized by its rough hairy leaves. The bark of the *American elm* contains a strong fiber from which the Indians made ropes.

Phloem necrosis and the Dutch elm disease kill many elm trees every year. Phloem necrosis is caused by a virus carried by the leafhopper. An infected tree cannot be recognized until its leaves begin to turn yellow and fall, too late for effective treatment. The Dutch elm disease also is carried by insects. See Dutch Elm Disease.

Famous elm trees include the "Washington Elm," which stood for many years in Cambridge, Mass. General Washington took command of the Continental Army under this tree in 1775. A beautiful white elm in Lancaster, Mass., is called "the pride of the state." New Haven, Conn., is often called the "City of Elms."

Scientific Classification. Elms belong to the family *Ulmaceae*. The American (white) elm is genus *Ulmus*, species *americana;* slippery elm, *U. fulva;* cork elm, *U. thomasi;* and English elm, *U. campestris*. Theodore W. Bretz

See also Hackberry.

ELMAN, MISCHA (1891-), a Russian-American violinist, made his first public appearance in St. Petersburg (now Leningrad) in 1904 with great success, and then made a spectacular tour of Germany. He played his first concert in the United States in 1908, and became an American citizen in 1923. He was born the son of a village schoolmaster in Talnoye, Russia. His father took him at the age of six to study at Odessa, and then at St. Petersburg with Leopold Auer. Dorothy DeLay

ELMENDORF AIR FORCE BASE, Alaska, is the headquarters of the United States Alaskan Command and Alaskan Air Command. It covers 13,560 acres and lies three miles east of Anchorage. It was established in 1940. Early in World War II, it was organized as an air supply base. It was named for Captain Hugh M. Elmendorf, an air corps officer killed in an air crash in 1933. The Alaskan Command, a unified command, directs all army, navy, and air force units in the state. The base serves as a supply depot. It is also the western end of the Distant Early Warning (DEW) radar line that guards against enemy air attack. John H. Thompson

ELMHURST COLLEGE is a coeducational arts and sciences school at Elmhurst, Ill. It is sponsored by the Evangelical and Reformed Church. Courses offered include business administration, sciences, education, languages, music, and religion. Elmhurst was chartered in 1865, and opened in 1871. For enrollment, see Universities and Colleges (table).

EL MINYA, *el MIN yuh*, or **AL-MINYA** (pop. 70,298; alt. 127 ft.), is a city in Egypt, about 140 miles south of Cairo. It serves as a Nile River port and trading center (see Egypt [color map]). Its industries center around the processing of raw materials. Products include cereals, cotton, and sugar cane.

ELMIRA, N.Y. (pop. 46,517; alt. 855 ft.), is a manufacturing center in the south-central part of the state (see New York [map]). The Chemung River flows through the city. Factories here make office equipment, fabricated structural steel, fire-fighting apparatus, chemicals, glass bottles, and prefabricated houses. Elmira was the home of Samuel L. Clemens (Mark Twain) while he was doing his greatest writing. The Mark Twain Study is on the campus of Elmira College. This was one of the earliest (1855) colleges for women in the United States. The city is also the site of Woodlawn National Cemetery, and the Arnot Art Gallery. South of Elmira is the Newtown Battlefield Park, in memory of the victory of General John Sullivan and his patriots over General Butler's forces of Iroquois and Tories in 1779. The first settlement on the site was Newtown, founded in 1790 by a group of Pennsylvanians. The town was incorporated in 1828 and became a city in 1864. Elmira has a council-manager government. William E. Young

ELMIRA COLLEGE is a privately controlled nonsectarian school for women at Elmira, N.Y. It was chartered in 1855, and classes were held that year. For enrollment, see Universities and Colleges (table).

ELMIRA SYSTEM. See Prison (Modern Reforms).

EL MISTI, *ME stee*, is a beautiful cone-shaped volcano in southern Peru. It lies in the Western Cordillera about 10 miles northeast of Arequipa. For location, see Peru (color map). This 19,144-foot-high mountain is one of hundreds of volcanoes in the Cordillera. But none of the others surpass it in beauty and symmetry. El Misti was of great religious significance to the ancient Inca, when Arequipa was one of their strongholds. The volcano figures in many Peruvian legends. The cone, snowcapped most of the year, furnishes much of the water used to irrigate the fields around Arequipa. Harvard University established an observatory near the summit of El Misti. C. Langdon White

EL MORRO NATIONAL MONUMENT is in western New Mexico. It contains ancient Zuñi cliff houses and a sandstone cliff eroded in the form of a castle. The face of this cliff, called Inscription Rock, contains more than 500 deciphered inscriptions, some made by early Spanish explorers. The 1,278.72-acre monument was established in 1906. C. Langdon White

ELODEA, *ee LOH dee uh,* is a plant that grows submerged in water. It is sometimes called *waterweed.* Its branching stems are densely covered with leaves that grow even more crowded toward the tip. These plants are commonly used in aquariums to keep the oxygen balance in the water. They are also used in classrooms to demonstrate that oxygen is one of the products of photosynthesis (see Photosynthesis). When exposed to light, oxygen bubbles appear around the leaves.

Scientific Classification. Elodea belongs to the frogbit family, *Hydrocharitaceae.* It is genus *Elodea* (also called *Anachris*), species *canadensis.*

ELOHIM, *eh LO him,* is a name used in the Old Testament for God. It is the plural form of the Hebrew word *Eloah* (God). Elohim means the *plural majesty of the one God.* The word is found in the first sentence of the Bible: "In the beginning God (Elohim) created the heaven and the earth" (Gen. 1:1).

ELON COLLEGE is a coeducational liberal arts school at Elon College, N.C. It is affiliated with the Congregational Christian Church, and maintains a strong department of philosophy and religion. It is noted for its music, science, and business departments, and offers various preprofessional courses. Elon grants A.B., B.S., and B.Mus. degrees. It was founded in 1889 by William S. Long, and was the first college to erect a separate building for religious education. For enrollment, see Universities and Colleges (table). L. E. Smith

EL PASO, *el PASS oh,* Tex. (pop. 276,687; alt. 3,695 ft.), serves as a gateway to Mexico. It lies on the Rio Grande in the far western part of Texas (see Texas [map]). El Paso ranks as the largest city on the United States-Mexico border. Its population more than doubled in the 10 years between 1950 and 1960. Neighboring Juárez is the largest Mexican border city. About 60 per cent of the people of El Paso are Mexican.

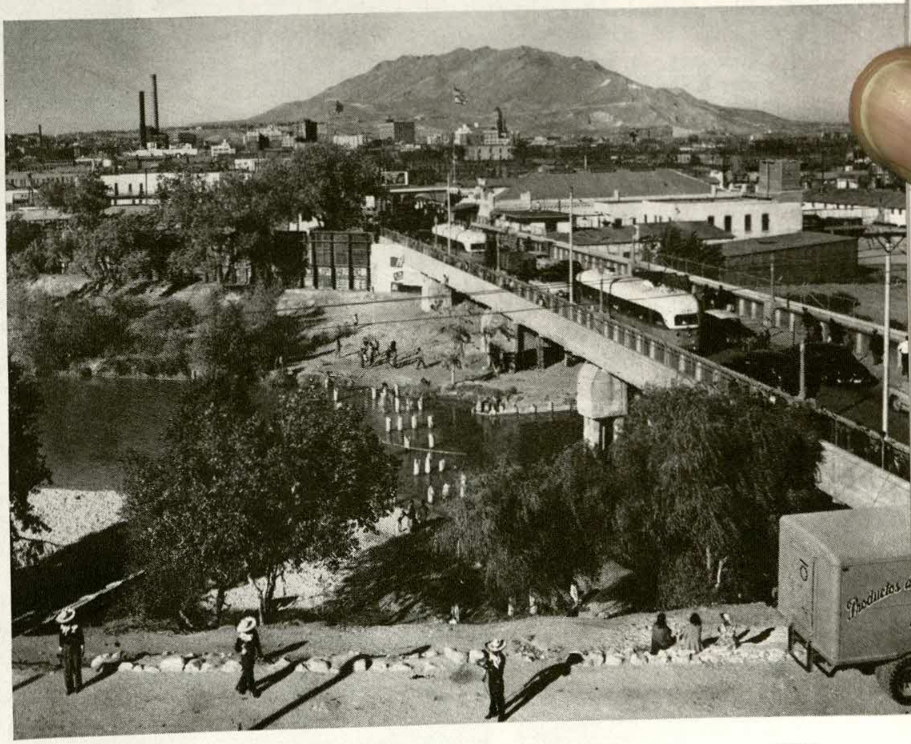
Industry and Trade. El Paso is the trading center of a region that includes Arizona, New Mexico, western Texas, and the northern part of Mexico. It has important cattle, copper, cotton, and tourist industries. The only lead plant in the Southwest was established here in 1885. Other industries include brewing, cement manufacturing, cotton processing, flour milling, the manufacture of optical instruments, meat packing, and oil refining. Elephant Butte Dam, an electric power and irrigation project on the Rio Grande northwest of El Paso, created one of the largest irrigation reservoirs in the world (see Elephant Butte Dam).

About 50 federal government branches are located here. The city is the home of Texas Western College, a branch of the University of Texas. Also situated here are the Army's Fort Bliss and William Beaumont General Hospital. Five railroads and several air, bus, and motor-freight lines serve the city. It lies at the crossroads of north-south and east-west highways.

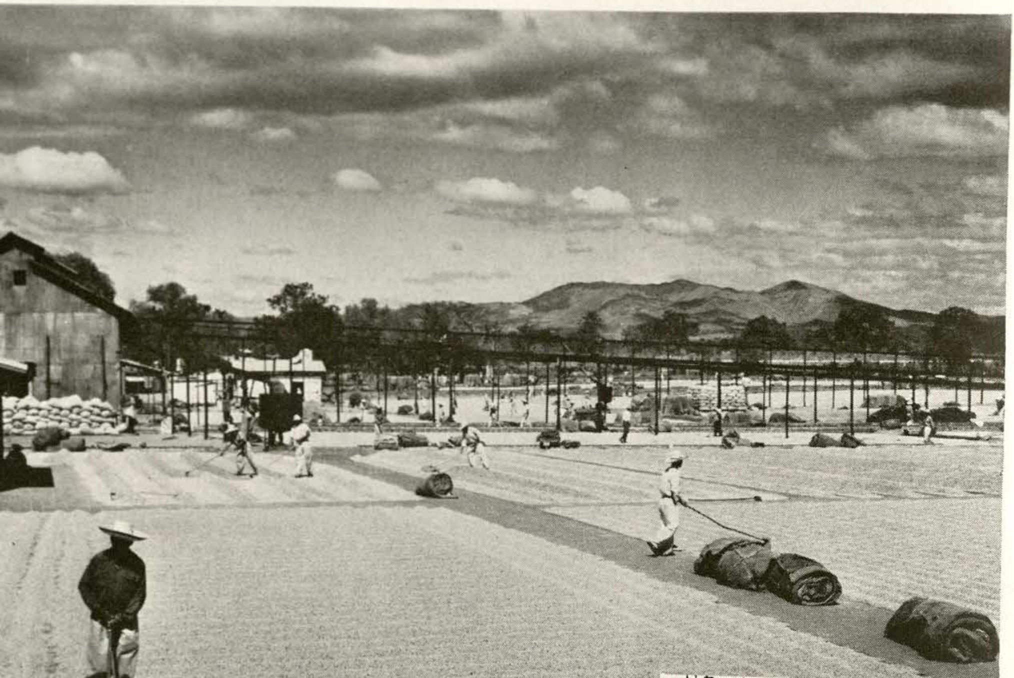
History. Spanish priests founded a mission in the area in 1659. Explorers, called *conquistadores,* crossed the Rio Grande here. The name *El Paso* is Spanish, and means *The Pass.* The city was incorporated in 1873.

The seat of El Paso County, the city has a mayor-council type of government. H. Bailey Carroll

Western Ways



El Paso, Tex., lies opposite Juárez, Mex., *foreground,* at the foot of the Franklin Mountains on the Rio Grande. A streetcar line connects the two cities. U.S. and Mexican customs and immigration officials board and inspect the cars.



Lanks, Black Star

Coffee Is The Leading Crop and chief export of El Salvador. The coffee beans go through many processes, such as drying, *above,* before they are put in bags and loaded for shipment.

EL SALVADOR, *el SAL vuh dawr,* is the smallest country in the Western Hemisphere. This tropical republic lies along the Pacific Ocean on the west coast of Central America. It is a beautiful land of cone-shaped volcanoes, clear blue mountain lakes, and gray and white beaches. The name of the country, in Spanish, is República de El Salvador, or Republic of El Salvador. San Salvador is the capital and largest city.

El Salvador is about one seventh the size of Illinois. It has about one fifth as many people as that state. Most Salvadorans are farmers. They raise crops on the high plateaus, on the fertile mountain slopes, and in the green river valleys. The rest of the people live in El Salvador's cities. These cities, with their Spanish-style buildings, look like many cities in the southwestern United States.

The mild climate and rich soil have made El Salvador a leading coffee-growing country. Tropical forests produce most of the world's *balsam of Peru,* a thick, sweet-smelling liquid used in cough sirup and other medicines.

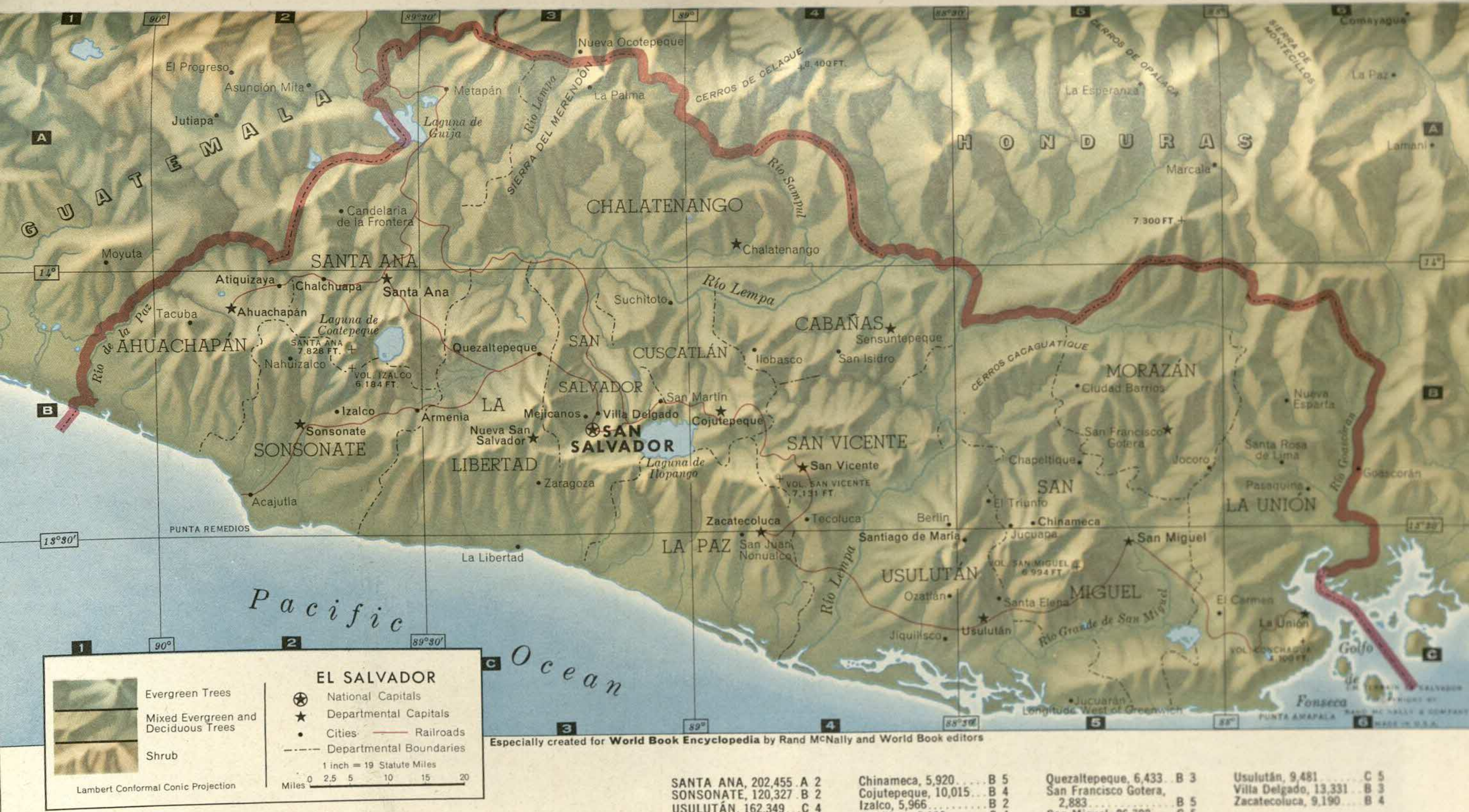
Indians who make their homes near the foot of Izalco live and dress much as their ancestors did hundreds of years ago. The ruins of ancient Indian temples lie in various parts of the country.

For the relationship of El Salvador to other American nations, see Central America; Latin America; Organization of American States; Pan American Union.

The Land and Its Resources

Location and Size. El Salvador lies on the west coast of Central America. The *Color Map* shows that it faces Honduras on the north and east, Guatemala on the northwest, and the Pacific Ocean on the south. El Salvador is the only Central American country without a Caribbean Sea coast. El Salvador covers 8,260 square miles.

Land Regions. El Salvador rises from a narrow coastal strip of tropical lowland to two low mountain ranges. These ranges lie parallel to the coast. Between them is a 2,000-foot-high, 230-mile-wide plateau. The range nearest the coast is mostly volcanic in origin. Izalco, the country's only active volcano, stands in southwestern El Salvador. Sailors call Izalco *The Lighthouse of the Pacific* because they can see either its bright flame or white smoke far out at sea. Frequent earthquakes in El



Especially created for **World Book Encyclopedia** by Rand McNally and World Book editors

EL SALVADOR

Departments

AHUACHAPÁN, 94,646	B 1
CABAÑAS, 77,628	B 4
CHALATENANGO, 105,859	A 3
CUSCATLÁN, 90,099	B 3
LA LIBERTAD, 144,004	B 3
LA PAZ, 96,843	C 3
LA UNIÓN, 109,715	B 6
MORAZÁN, 96,729	B 5
SAN MIGUEL, 171,234	B 5
SAN SALVADOR, 296,452	B 3
SAN VICENTE, 87,577	B 4
SANTA ANA, 202,455	A 2
SONSONATE, 120,327	B 2
USULUTÁN, 162,349	C 4

Source: Latest available official figures.

Cities

Ahuachapán, 10,294	B 2
Armenia, 5,503	B 2
Atiquizaya, 5,276	B 2
Chalatenango, 4,128	A 4
Chalchuapa, 9,855	B 2
Chinameca, 5,920	B 5
Cojutepeque, 10,015	B 4
Izalco, 5,966	B 2
Jiquilisco, 3,196	C 4
Jucuapa, 4,385	B 5
La Libertad, 2,841	C 3
La Unión, 7,890	C 6
Mejicanos, 9,389	B 3
Metapán, 2,811	A 3
Nueva San Salvador, 18,313	B 3
Quezaltepeque, 6,433	B 3
San Francisco Gotera, 2,883	B 5
San Miguel, 26,702	C 5
San Salvador, 161,951	B 3
San Vicente, 10,950	B 4
Santa Ana, 51,702	B 2
Santiago de María, 6,128	C 5
Sonsonate, 17,949	B 2
Suchitoto, 3,521	B 3
Usulután, 9,481	C 5
Villa Delgado, 13,331	B 3
Zacatecoluca, 9,190	B 4

Physical Features

Cerros Cacaguatique (Hills)	B 5
Laguna de Guija (Lake)	A 3
Lempa, R.	B 4
Paz, R. de la	B 1

San Salvador's Cathedral stands before a background of extinct volcanoes. The cathedral is of a Spanish Gothic style. It was built of wood to protect it from earthquakes which often strike the capital city.

Crossman, Black Star

Salvador cause severe damage and loss of life.

The fertile green valley of the navigable Lempa River crosses the plateau and mountain ranges from north to south. Lake Ilopango, El Salvador's largest lake, lies in the crater of a dead volcano near San Salvador.

Natural Resources. El Salvador's fertile soil is its chief natural resource. Balsam trees produce a valuable sap called *balsam of Peru* that is used in medicines (see Balsam of Peru). The Lempa River supplies power for the country's largest hydroelectric plant. Small deposits of minerals include gold, silver, copper, zinc, iron, coal, lead, mercury, gypsum, sulfur, and limestone.

FACTS IN BRIEF

Form of Government: Republic.

Capital: San Salvador.

Official Language: Spanish.

Area: 8,260 square miles. *Greatest distance:* (east-west) 160 miles; (north-south) 60 miles. *Coast line,* 160 miles.

Population: 1,855,917. *Density,* 224 persons to the square mile. *Distribution,* rural, 64 per cent; urban, 36 per cent.

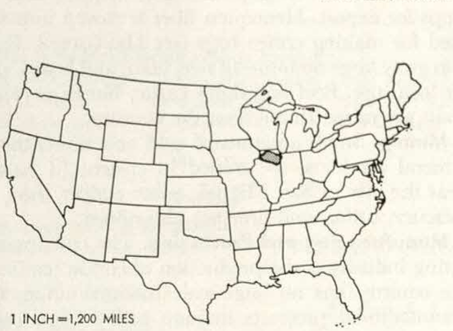
Chief Products: *Agriculture,* beans, cattle, coffee, corn, cotton, henequen, rice, rubber, sugar, tobacco. *Forest Products,* balsam. *Mining,* coal, copper, gold, iron, lead, lime, mercury, sulfur, zinc. *Manufacturing and Processing,* alcohol, cigarettes, cement, cotton textiles, henequen coffee bags, leather goods.

Flag: The flag has blue stripes at the top and bottom and a white stripe bearing the coat of arms in the middle. See Flag (color picture, Flags of the Americas).

National Anthem: "Himno Nacional de El Salvador" ("National Hymn of El Salvador").

National Holiday: Independence Day, September 15.

Money: *Basic unit,* Colon. For its value in dollars, see Money (table, Values).



The U.S. Is About 450 Times the Size of El Salvador.

Climate. Most of El Salvador has a healthful, mild climate. Temperatures on the plateau seldom rise above 98° F. or fall below 50° F. About 74 inches of rain falls on the plateau every year. The coastal lowlands are hotter and more humid than the rest of the country.

Life of the People

The People. El Salvador has a population of 1,855,917. About 76 of every 100 Salvadorans are dark-skinned *mestizos* (mixed white and Indian). About 21 of every 100 are Indians. Most of the Indians belong to the Pipil or Lenca tribes. The rest of the people are whites. The people of El Salvador speak Spanish.

An average of 224 persons live on each square mile. About two thirds of the people live in farm regions, and about one third live in city areas.

Family Life in El Salvador is similar to that in most Latin-American countries (see Latin America [Way of

Life]). Most Salvadorans have large families who work together to help cultivate the fields and harvest the crops. Farm communities have small cottages with thick, white stucco walls and red or pink tile roofs. In the cities, people live in houses and apartments similar to those in the United States and Canada. About 40 of every 100 homes have electricity.

Salvadorans eat many foods made of corn, rice, and beans. *Tortillas* (pronounced *tohr TEE yahs*), or corn cakes, are a favorite food, and coffee is the chief drink.

Most Salvadorans belong to the Roman Catholic Church. The longest and most important of the country's many holidays and fiestas (feast days) is the Fiesta of the Holy Savior, held from July 24 to August 6. During this holiday, the people take part in gay parades and solemn religious processions and ceremonies.

Work of the People

About 63 of every 100 persons make their living in agriculture. The rest work at such occupations as business, manufacturing, and transportation.

Agriculture. About three fifths of El Salvador's farmers work on large plantations. The rest own or rent their small farms. Coffee is the most important crop, and El Salvador ranks among the leading coffee-growing countries of the world. Coffee grows on the plateaus and lower mountain slopes.

Since the early 1950's, the government has encouraged farmers to plant sugar, cotton, henequen, and other crops for export. Henequen fiber is woven into thread used for making coffee bags (see HENEQUEN). Farmers also grow large amounts of rice, corn, and beans, mostly for local use. Beef and dairy cattle, horses, sheep, and goats are raised throughout the country.

Mining. Small amounts of gold and silver, the chief mineral products, are mined in eastern El Salvador, near the city of San Miguel. Some copper, zinc, lead, mercury, sulfur, and lime are also mined.

Manufacturing and Processing. The chief manufacturing industry is the production of cotton textiles, but the country has no large-scale manufacturing. Other manufactured products include coffee bags, cement, cigarettes, alcohol, and leather goods.

Trade. El Salvador sells more than 100,000,000 pounds of coffee a year, mostly to the United States. Other exports include sugar, henequen, gold, silver, balsam of Peru, and cotton. The chief imports include cotton and wool textiles, machinery, chemicals, drugs, and dyes. Most imports come from the United States. El Salvador usually exports more than it imports.

Transportation. About 385 miles of narrow-gauge railroads connect El Salvador's larger cities. Trucks, buses, and automobiles travel on 1,800 miles of public roads. The Pan American Highway crosses the Lempa River over the Cuscatlán bridge in east-central El Salvador. This 1,350-foot bridge is the longest suspension bridge in Central America. Several international air lines and shipping lines serve El Salvador. San Salvador airport is the chief air terminal. La Unión and La Libertad are the chief seaports.

Communication. Telephone and telegraph lines connect most of the cities. El Salvador has several radio stations. Most of the country's 10 daily newspapers are published in San Salvador. The city also has some book and magazine publishers.

Charles P. Weimer

A San Salvador Public Market sells hats, baskets, and other goods. San Salvador also has many modern shops and buildings.

Education

Education is free in El Salvador. The law requires all children between the ages of 7 and 13 to attend school, but about half the people cannot read or write. Because of a shortage of classrooms and teachers, many children do not go to school, especially in farm areas. The government expanded the educational system during the 1950's by building new schools and training new teachers. The National University, founded by the government in 1841, is in San Salvador.

The Arts

Painting developed slowly in El Salvador because the people had little interest in art and did not support it. Juan Francisco Cisneros (1825-1878), a portrait painter, became the country's first well-known artist. Salvadoran artists of the 1900's include José Medjía Vides (1903-) and Salvador Salazar Arrué (1899-).

El Salvador's most original architecture is found in churches that were built during the 1700's. Low roofs, thick walls, and small domes enable these simple buildings to withstand frequent earthquakes.

Government

El Salvador's government resembles that of the United States in many ways. The Salvadoran constitution, adopted in 1950, provides for a system of checks and balances similar to that of the United States (see UNITED STATES, GOVERNMENT OF [Separation of Powers]). The president heads the government. The constitution states that the president cannot be re-elected within six years after the end of a term. However, some of El Salvador's presidents have become dictators and have served more than six years in a row. El Salvador's

56-member national legislature has only one house, unlike that of the United States, which has two houses. As in the United States, the Supreme Court is the highest court in El Salvador.

Persons over the age of 18 may vote in national elections. The law requires all Salvadoran men to vote. However, not all women have to vote. For example, unmarried women over the age of 30 and married women over 25 do not have to cast ballots. The law prohibits all clergymen from voting or holding public office. Political parties include the Revolutionary Party of Democratic Action and the Party of Reform Action.

El Salvador has an army of about 3,000 men. The country also has a national guard and a small air force.

El Salvador is divided into 14 departments for local government. The president appoints the governors of the departments for four-year terms.

History

Early Days. The Pipil tribe was the largest and most advanced of the many Indian tribes that lived in El Salvador before the Spanish conquerors arrived. The Pipil were descendants of the ancient Toltec and Aztec peoples. They called their land *Cuscatlán*, or *Land of Jewels*. In 1524, the Spaniard Pedro de Alvarado (c.1495-1541), one of Hernando Cortes' soldiers, crossed into El Salvador from Guatemala in search of gold and silver (see ALVARADO, PEDRO DE). After a short, fierce struggle, he conquered the Pipil and other Indian tribes. In 1525, Alvarado founded the city of San Salvador de Cuscatlán, now called San Salvador. The city, and eventually the whole country, was named for Alvarado's final victory over the Indians. This battle took place on the eve of the Roman Catholic festival of San Salvador (Holy Savior) in April, 1525. For the next 300 years, El Salvador was a Spanish colony.

Independence and Confederation. In 1821, El Salvador and the other Central American colonies broke away from Spain and joined the Mexican Empire. José Matías Delgado (1767-1832), a lawyer and Roman Catholic priest, was the outstanding Salvadoran leader during this period (see DELGADO, JOSÉ MATÍAS). In 1823, the Central American states withdrew from Mexico, adopted a constitution, and formed the United Provinces of Central America. National jealousies and personal ambitions weakened this new union, and it began to crumble in 1839. Two years of civil war followed. El Salvador became an independent republic with its own constitution in 1841.

Progress. During the rest of the 1800's, frequent revolutions and wars shook El Salvador. Some of the country's weak presidents were controlled by the strong dictators of neighboring republics. One of these dictators, Rafael Carrera (1814-1865) of Guatemala, used his army several times to force El Salvador to accept presidents of his choice. During the 1800's, El Salvador fought in many wars caused by the attempts of the Central American republics to form another union.

After 1900, El Salvador's neighbors interfered less in the country's internal affairs. The government became more stable and efficient under a series of strong dictators. From 1913 to 1927, Carlos Meléndez (1861-1919) and members of his family controlled the presidency. The coffee industry grew rapidly, and the country began to prosper. In 1931, General Maximiliano Martínez (1882-) seized the government and ruled as dictator for 13 years. El Salvador declared war on Germany, Italy, and Japan in December, 1941, but took no part in the fighting of World War II.

Revolution. In 1944, the people revolted against Martínez because of his cruel and undemocratic methods. They elected General Salvador Castañeda Castro (1888-) president. In 1945, El Salvador became a charter member of the United Nations. An army revolt deposed Castañeda Castro in 1948 because of his attempts to become a dictator. A group of army officers ruled the country for the next two years.

Recent Developments. Major Oscar Osorio (1910-) was elected president in a free election in 1950. A new democratic and progressive constitution went into effect. Osorio's government improved economic and social conditions. The Lempa River hydroelectric project began operating in 1954. This project doubled El Salvador's electric power. The government built new schools, and started a program to teach more adults how to read and write. New industries developed, and new crops and agricultural methods were introduced. The people elected Colonel José María Lemus (1912-) president in 1956. In 1957, Salvadoran engineers completed a $2,400,000 dam on Lake Guija on the Guatemalan border. A military group overthrew Lemus in October, 1960, and a *junta*, or council, of six men took charge of the government. In January, 1961, a second junta, described as "anti-communist," ousted the first group.

CHARLES C. CUMBERLAND

Related Articles in WORLD BOOK include:

Alvarado, Pedro de
Balsam of Peru
Central America
Coffee (table)
Cortes, Hernando
Delgado, José Matías
Pan American Highway
San Miguel
San Salvador
Santa Ana

Outline

I. The Land and Its Resources
  A. Location and Size
  B. Land Regions
  C. Natural Resources
  D. Climate
II. Life of the People
  A. The People
  B. Family Life
III. Work of the People
  A. Agriculture
  B. Mining
  C. Manufacturing
  D. Trade
  E. Transportation
  F. Communication
IV. Education
V. The Arts
VI. Government
VII. History

Questions

How does El Salvador compare in size with other countries in the Western Hemisphere? How does it compare in size with your state or province?

Why is the Lempa River important to El Salvador?

What is the longest suspension bridge in Central America?

What mountain in El Salvador is called *The Lighthouse of the Pacific?* Why does it have this name?

What is *balsam of Peru?* What are its uses?

Why do the churches of El Salvador have thick walls and low roofs?

What is El Salvador's chief natural resource?

What makes El Salvador a leading coffee-grower?

How did El Salvador receive its name?

How does the organization of the National Assembly differ from that of the United States Congress?

ELSSLER, FANNY. See DANCING (Ballet).

EL TORO MARINE CORPS AIR STATION, Calif., is the headquarters of the United States Fleet Marine Force, Pacific, Aircraft Command. It also houses a marine aircraft wing and a marine corps air station. The base lies 10 miles southeast of Santa Ana, and covers 4,412 acres. The marine corps established the base in 1942 in what had been a bean field. The base received its name from the nearby community of El Toro. It is the largest marine corps tactical operating airdrome on the Pacific Coast. JOHN H. THOMPSON

ELVER. See EEL.

ELVES. See FAIRY.

ELY, *EE lih,* Nev. (pop. 4,018; alt. 6,000 ft.), is the center of one of the great mining districts of the United States. Copper from the immense Ruth Pit is the chief product, but gold, silver, and lead are also mined. Ely, about halfway between Salt Lake City and Reno, is also a tourist center. For location, see NEVADA (map). The Lehman Caves National Monument is nearby. The town was founded as a gold-mining camp in 1868. A. J. Underhill borrowed $5,000 from John Ely, a colorful western mining man, to buy and lay out the townsite, and named it for Ely. LUCIUS BEEBE

ELYSIAN FIELDS, *ee LIZH un,* were sometimes called the ISLANDS OF THE BLESSED in Greek mythology. Good souls were sent there after death, if the three judges of the Lower World decided they had led pure lives. The Fields were a land of song and sunlight, and the air was sweet and cool. The good souls lived there in simple joy among the flowers and meadows. PADRAIC COLUM

ELYTRON (plural, *elytra*), is the horny front wing of a beetle. See BEETLE (The Bodies of Beetles).

ELZEVIR, *EL zuh vir,* is the name of a famous family of Dutch printers. Between 1583 and 1675, they published more than 5,000 books. They specialized in pocket-sized editions of the classics, with engraved title pages and solid matter set in small type. "Elzevirs," as their books are called, are noted for their correct editing, neatness of print, and convenient size.

Louis Elzevir (1540?-1617), founder of the enterprise, settled in Leiden as a bookseller in 1580. He began to publish books three years later. Five of his sons followed the same line of business.

Bonaventure Elzevir (1583-1652), the youngest son of Louis, formed a partnership with his nephew, Abraham, in 1625. They became renowned for their elegant editions of classical works. RAY NASH

Rugged Canyon Walls Limit the Area of Ely, Nev.

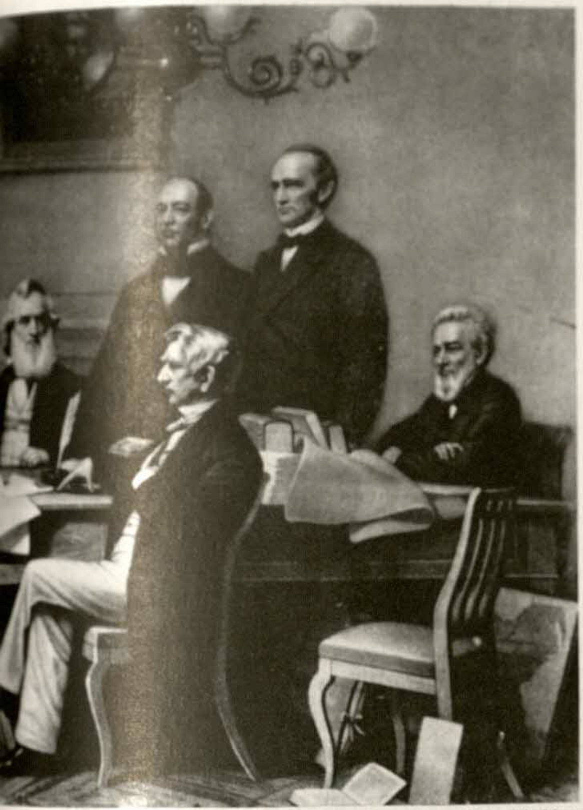
Skyline Magazine

EMANCIPATION PROCLAMATION. Great pressure was brought to bear upon President Abraham Lincoln to free the slaves at the outbreak of the Civil War, but he refused. He steadily opposed the extension of slavery into new territory, but in his inaugural address he repeated his often-made statement that he had no wish to interfere with slavery where it already existed. During the early months of the war, Lincoln held that he was fighting to save the Union, not to free the slaves.

Events Leading to the Proclamation

As the war developed into a prolonged struggle, more and more Northerners demanded that slavery should be abolished. Lincoln knew also that Great Britain would never intervene on the side of the South if the war became a crusade to free the slaves. By the summer of 1862, with the war going badly for the North, the President was ready to reverse his earlier stand. He waited for a Union victory so that the decision would not look like an act of desperation. On September 22, 1862, a few days after Union forces defeated General Robert E. Lee's troops at Antietam, Lincoln issued a preliminary proclamation which stated that if the seceded states did not lay down their arms and return to the Union by January 1, 1863, he would declare their slaves to be "forever free."

When the appointed day came, Lincoln issued the Emancipation Proclamation. He took this action as commander-in-chief of the army and navy of the United States. Under the ordinary peacetime powers of the President, Lincoln did not have such authority. Issued



Brown Bros., National Archives

Lincoln Met With His Cabinet on September 22, 1862, and read them the preliminary Emancipation Proclamation. Frank Carpenter's painting shows, *from left to right,* Edwin M. Stanton, Salmon P. Chase, Lincoln, Gideon Welles, Caleb B. Smith, William H. Seward, Montgomery Blair, and Edward Bates. The final proclamation, shown in part at *right,* was issued January 1, 1863.

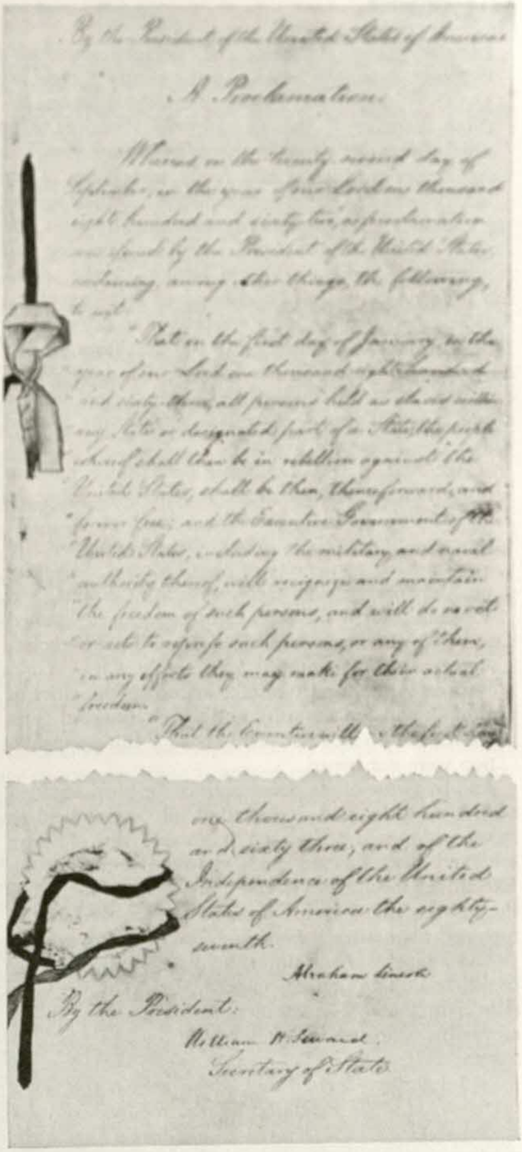
"as a fit and necessary war measure," his proclamation freed slaves only in those territories still in rebellion. The Emancipation Proclamation was of little military importance. While the war lasted, most of the slaves remained loyal to their masters. But it satisfied Northern antislavery opinion, and it brought the United States a step closer to the doctrine of the Declaration of Independence that "all men are created equal." The slave states that remained in the Union did not abolish slavery until Amendment 13 became law throughout the nation nearly three years later, on December 18, 1865.

JOHN D. HICKS

The Emancipation Proclamation

Whereas, on the twenty-second day of September, in the year of our Lord one thousand eight hundred and sixty-two, a proclamation was issued by the President of the United States, containing, among other things, the following, to wit:

That on the first day of January, in the year of our Lord one thousand eight hundred and sixty-three, all persons held as slaves within any State, or designated part of a State, the people whereof shall then be in rebellion against the United States, shall be



By the President of the United States of America:

A Proclamation.

Whereas on the twenty second day of September, in the year of our Lord one thousand eight hundred and sixty two, a proclamation was issued by the President of the United States, containing, among other things, the following, to wit:

"That on the first day of January, in the year of our Lord one thousand eight hundred and sixty three, all persons held as slaves within any State or designated part of a State, the people whereof shall then be in rebellion against the United States, shall be then, thenceforward, and forever free; and the Executive Government of the United States, including the military and naval authority thereof, will recognize and maintain the freedom of such persons, and will do no act or acts to repress such persons, or any of them, in any efforts they may make for their actual freedom.

"That the Executive will, on the first day

one thousand eight hundred and sixty three, and of the Independence of the United States of America the eighty-seventh.

Abraham Lincoln

By the President:

William H. Seward,
Secretary of State

then, thenceforward, and forever free; and the Executive Government of the United States, including the military and naval authority thereof, will recognize and maintain the freedom of such persons, and will do no act or acts to repress such persons, or any of them, in any efforts they may make for their actual freedom.

That the Executive will, on the first day of January aforesaid, by proclamation, designate the States and parts of States, if any, in which the people thereof respectively shall then be in rebellion against the United States; and the fact that any State, or the people thereof, shall on that day be in good faith represented in the Congress of the United States by members chosen thereto at elections wherein a majority of the qualified voters of such State shall have participated, shall in the absence of strong countervailing testimony be deemed conclusive evidence that such State and the people thereof are not then in rebellion against the United States.

Now, therefore, I, Abraham Lincoln, President of the United States, by virtue of the power in me vested as Commander-in-Chief of the Army and Navy of the United States, in time of actual armed rebellion against the authority and government of the United States, and as a fit and necessary war measure for suppressing said rebellion, do on this first day of January, in the year of our Lord one thousand eight hundred and sixty-three, and in accordance with my purpose so to do, publicly proclaimed for the full period of 100 days from the day first above mentioned, order and designate as the States and parts of States wherein the people thereof, respectively, are this day in rebellion against the United States, the following, to wit:

> Arkansas, Texas, Louisiana (except the parishes of St. Bernard, Plaquemines, Jefferson, St. John, St. Charles, St. James, Ascension, Assumption, Terre Bonne, Lafourche, St. Mary, St. Martin, and Orleans, including the city of New Orleans), Mississippi, Alabama, Florida, Georgia, South Carolina, and Virginia (except the forty-eight counties designated as West Virginia, and also the counties of Berkeley, Accomac, Northampton, Elizabeth City, York, Princess Anne, and Norfolk, including the cities of Norfolk and Portsmouth), and which excepted parts are for the present left precisely as if this proclamation were not issued.

And by virtue of the power and for the purpose aforesaid, I do order and declare that all persons held as slaves within said designated States and parts of States are, and henceforward shall be, free; and that the Executive Government of the United States, including the military and naval authorities thereof, shall recognize and maintain the freedom of said persons.

And I hereby enjoin upon the people so declared to be free to abstain from all violence, unless in necessary self-defense; and I recommend to them that, in all cases where allowed, they labor faithfully for reasonable wages.

And I further declare and make known that such persons of suitable condition will be received into the armed service of the United States to garrison forts, positions, stations, and other places, and to man vessels of all sorts in said service.

And upon this act, sincerely believed to be an act of justice, warranted by the Constitution upon military necessity, I invoke the considerate judgment of mankind and the gracious favor of Almighty God.

In witness whereof, I have hereunto set my hand and caused the seal of the United States to be affixed.

Done at the city of Washington, the first day of January, in the year of our Lord one thousand eight hundred and sixty-three, and of the independence of the United States of America the eighty-seventh.

By the President: Abraham Lincoln

William H. Seward, Secretary of State.

See also ADAMS, JOHN Q. (The Gag Rules); UNITED STATES CONSTITUTION (Amendment 13).

EMBALMING, *em BAHM ing,* is the artificial preservation of dead bodies. Bodies are *embalmed* for many reasons. Embalming keeps a body lifelike in appearance during the time it lies in state prior to a funeral. It also meets the requirements of some religions, and helps to prevent the spread of disease.

Ancient Embalming. Embalming was a highly skilled profession in ancient Egypt as early as 4000 B.C. The Egyptians believed that a *mummy,* or preserved body, was necessary for the survival of the soul. The embalming process varied according to the wealth or prominence of the deceased person. The embalmer soaked the body in a soda solution and filled the body cavities with oils, spices, and resins. The use of pitch and tars often gave mummies a black appearance.

In 1880, the mummy of King Mer-en-re was found in his pyramid at Saqqara, where it had been perfectly preserved for 4,500 years. In 1881, archaeologists discovered at Deir El-Bahari the body of Ramses II, perfectly preserved after 3,200 years.

The Greeks, Romans, and Hebrews gave less attention to embalming than did the Egyptians. They usually anointed bodies with spices, perfumes, and oils. The early Christians did not generally practice embalming because of their objection to the mutilation of the bodies of the dead.

Modern Embalming began in the early 1700's. A German embalmer used alcohol as a preservative and injected a fluid into the arteries. But his secret of preserving color and form died with him. Other embalmers injected oils into arteries. Embalming was used in the United States during the Civil War to make it easier to send home bodies of soldiers. Modern embalmers remove body liquids, and then inject a fluid containing formaldehyde, mercuric chloride, zinc chloride, and alcohol. A person who wishes to enter the embalming profession usually enrolls in a school of mortuary science. He then serves an apprenticeship and must pass a state board examination to receive a license to practice as a *mortician.*

CHARLES L. WALLIS

See also FUNERAL CUSTOMS; MORTICIAN; MUMMY.

EMBARGO, *ehm BAR go,* is an order stopping the movement of persons and property. It may include seizing the goods or detaining the persons involved. The term primarily refers to an order by the government of a country to stop the movement of merchant ships or the movement of certain goods into or out of its ports. A government uses an embargo in times of peace to exert pressure on another government for political or economic reasons. Or it may use an embargo to detain property when war threatens. If war breaks out, it then seizes the property as a prize of war. If war does not break out, the property is usually restored to its rightful owners. Embargo does not properly include acts occurring after war begins, or cases of temporary, rather than permanent, prohibition.

Hostile Embargo is imposed on property belonging to an unfriendly country. The Hague Convention of 1907 condemned the use of hostile embargoes.

Civil Embargo is a restraint placed by a country on its own people and property. A civil embargo may keep needed supplies in the country, or prevent vital materials from being shipped to warring nations.

Freight Embargo. In modern usage, *embargo* also includes an order issued by a transportation company or regulatory agency restricting the movement of certain freight over the company's lines. This is usually an emergency measure because of traffic, strikes, bad weather, or similar conditions.

The Embargo Act, passed by Congress in December, 1807, tried to protect American ships from British and French attacks, and to force France and Britain to grant concessions by depriving them of goods. U.S. merchant ships were forbidden to carry goods to other countries. Congress passed the Non-Intercourse Act on Mar. 1, 1809. Warren A. Jackman

See also Blockade; Jefferson, Thomas (Commercial Retaliation); Non-Intercourse Act.

EMBASSY. See Ambassador.

EMBEZZLEMENT, *ehm BEHZ'l munt,* is the crime committed when a person entrusted with another person's money or property illegally takes it for his own use. This crime is not like a robbery, where a thief takes something that belongs to someone else. The owner has already turned the property over to the embezzler.

Embezzlement is a modern crime. In early English common law, a man could not be charged with theft if the property he took had been turned over to him legally, even though he did not use the property in the way its owner wanted. But merchants and bankers needed a law to protect their property while their employees handled it. The courts devised the crime of embezzlement to cover this situation.

The punishment for embezzlement is imprisonment. Usually the penalty is the same as for larceny, a year or more for a major theft and less than a year for a minor one (see Larceny). Fred E. Inbau

EMBLEM is a symbol of an idea, or of things for which a person, a country, or an organization stands. The badge of a policeman is the emblem of law and authority. The United States flag is the emblem of the United States. The white dove, a symbol of peace, has been worked into many emblems. See also Symbol.

EMBOLISM, *EHM boh liz'm,* is a condition in which a blood vessel becomes blocked by some particle floating in the blood. The blocking particle is known as an *embolus*. Embolism may occur in any blood vessel, but is most serious when it occurs in the blood vessels of the lungs, heart, or brain. Part of a blood clot, a bubble of air, a fat globule, tissue from a tumor, masses of bacteria, or even parasitic worms may cause embolism. The patient who has an embolism should be placed under a physician's care. See also Apoplexy. Paul R. Cannon

EMBOSSING, *em BAWS ing,* is a process in which a raised design is stamped or pressed by mechanical means on the surface of a material, such as leather, paper, wood, or metal. One method of embossing is to press the material between two shaping tools, called *dies*. Letterheads and cards are embossed in this way. The paper or card is first dampened. A stamping machine is used to emboss coins. The metal is forced into shape under great pressure. The Greeks probably invented the art of embossing. Their coins were embossed in dies held on an anvil. Modern coins also are made in this manner. See Die and Diemaking.

Wood may be embossed by soaking it in water and then pressing a red-hot iron mold upon it. Dies can be used to emboss wood veneers and some plastics.

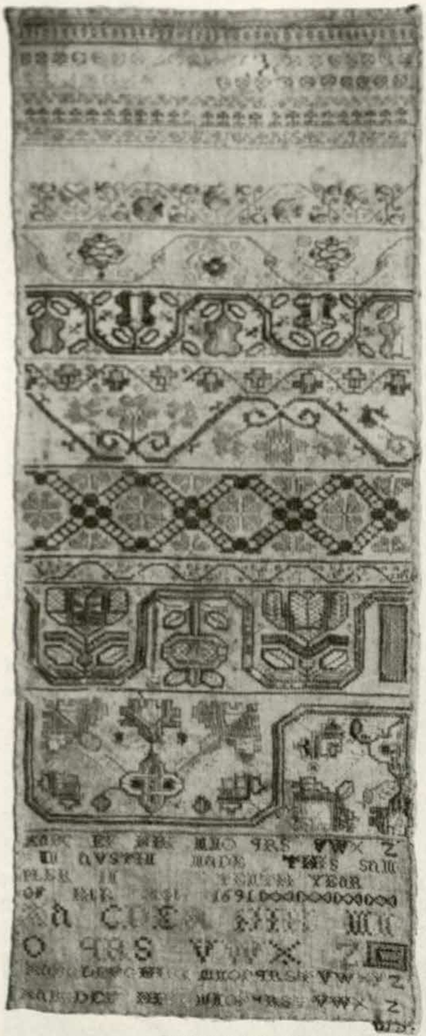
The term *repoussé* is loosely used as a synonym for embossing, but this is not strictly correct. In embossing, the surrounding field is pressed back, leaving the design in relief. In repoussé, the design is beaten out from the back by hand. William M. Milliken

Embossed Leather makes attractive purses, book covers, and stationery folders. Many interesting designs are made by striking specially tooled punches with a wooden mallet.

Chicago Board of Education

Embossed Metal Lampshade decorated with sailboats, water, and sea gulls. The metal is first cut and laid on a board. Then the holes are punched and the metal is riveted together.

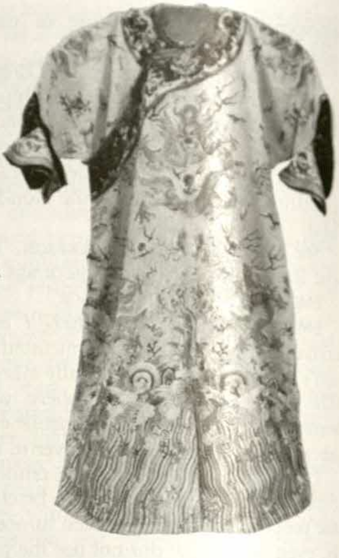
Chicago Board of Education



Courtesy Museum of Fine Arts, Boston

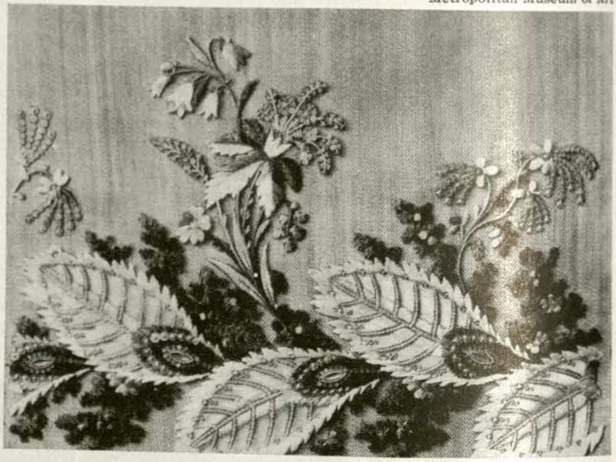
A New England Sampler made by a 10-year-old girl in 1691 is typical of embroidery popular in colonial America. Young girls then practiced stitches on these linen canvases.

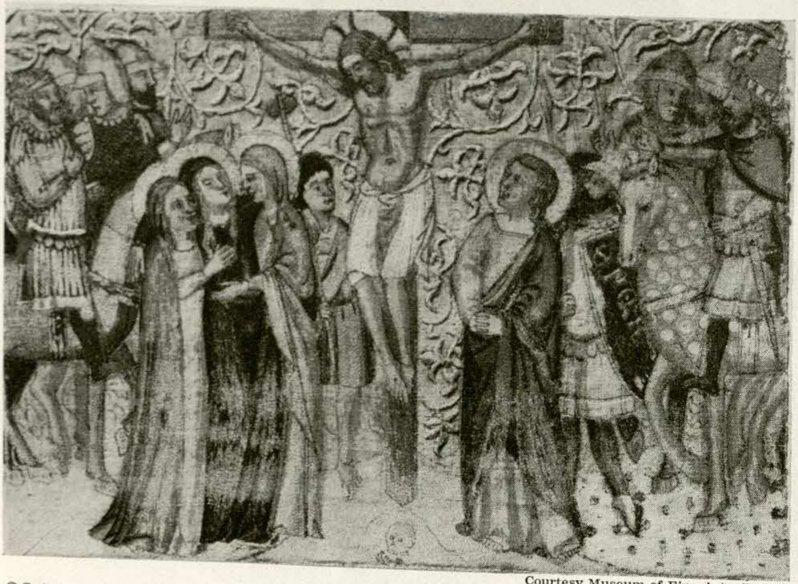
A Silk Court Robe shows the style of embroidery that was popular in China during the Cheng Dynasty (1723-1735). The designs show the rank of the person for whom the gowns were made.



Metropolitan Museum of Art

A Floral Design formed an elaborate embroidered border for a French dress of the 1800's. Seamstresses made these decorated gowns for ladies of the court.





Courtesy Museum of Fine Arts, Boston

A Crucifixion Scene made in Italy in the 1300's represents European medieval tapestries. Embroidered pieces like this once lined the walls of castles, churches, and even streets of towns on special occasions.

EMBROIDERY is the art of stitching a pattern or design on cloth with needle and thread. This kind of needlework is sometimes called *needle-painting*. The word *embroidery* comes from an Anglo-Saxon word which means *edge* or *border*.

Embroidery Stitches are difficult to classify, because there are many different kinds used in many different ways. One basic pattern, the *cross-stitch*, consists of two slanted stitches that form an *x*. Some stitches cover an entire area. They include the many *canvas stitches* (variations of the cross-stitch), and different kinds of *needle point* (see Needle Point). Other stitches outline a figure or fill it in solidly with stitches placed close together. The *couching stitch* fastens a thick thread to a fabric with small stitches placed at equal distances. The *cording stitch* is similar to the couching stitch, but the oversewing stitches are vertical and close together.

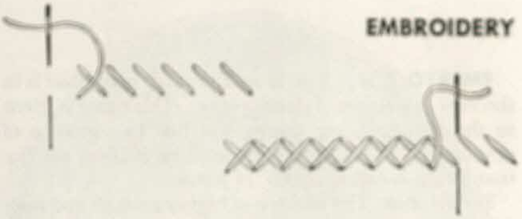
Decorative stitches include the *chain stitch*, which consists of a series of loops, and the *French knot*, which is made by twisting the thread twice around the needle and inserting the needle where it originally came out. *Broderie Anglaise* consists of small shapes cut out of the foundation material and bordered with a cording stitch. Some embroiderers use a technique called *appliqué* to create figures. These craftsmen cut the figures out of a material of contrasting color or texture. They then fasten them to the foundation cloth with ornamental stitches (see Appliqué).

Many countries have developed their own distinctive embroidery. The Chinese use silk and gold thread on silk damask to embroider flowers, dragons, birds, and delicate scenes. In India, craftsmen fasten beads, bangles, or tiny mirrors on silk cloth with brilliant silk threads. The Balkan countries use bold, simple folk designs to enrich necklines or to form wide bands at the bottoms of skirts. The French and Swiss embroider delicate flower sprays and scallops on fine linens. The people of the Island of Madeira are well-known for the perfection of their *festoons*, or scalloped edges. The Italians often use canvas stitches on white linen to embroider conventionalized representations of flowers, birds, animals, or fountains.

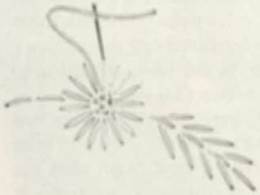
History. The art of embroidery has an ancient history. Prehistoric peoples often created patterns when they stitched skins together for their clothing. American Indians sewed feathers, quills, and beads in elaborate patterns on their clothing. Ancient Egypt, Persia, Syria, Greece, and Italy produced embroidery using linen, silk, or metallic threads. The people of these countries decorated handwoven cotton, linen, and silk fabrics to be used in making their wearing apparel or for use as home furnishings.

During the Middle Ages, embroidery reached its highest development. Nuns in convents and ladies at home embroidered rich designs on linens for church altars, priests' robes, wall hangings, and clothing worn on state occasions. Craftsmen began to embroider with pearls during the 1300's. They also combined embroidery with lace for some of the finer fabrics. In the 1600's and 1700's, girls between the ages of 8 and 12 made samplers to display their skill in various embroidery stitches. A girl often embroidered her name and the date at the bottom of her sampler. HELEN MARLEY CALAWAY

See also Beadwork; Colonial Life in America (Needlework); Petit Point; Sampler; Tapestry.

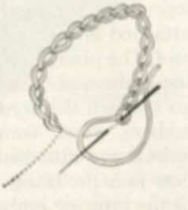


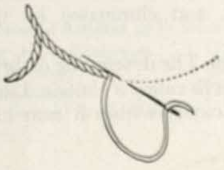
To Make the Cross-Stitch, bring the needle up from the lower right-hand corner, making a line of slanting stitches. On the return row, come down from the upper right-hand corner.



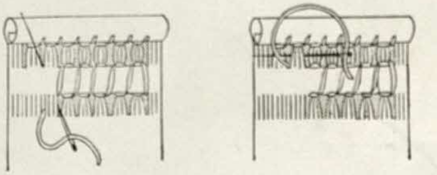
The Stroke Stitch is not only easy to make but versatile. A child can sew flowers, leaves, and many designs with this common single stitch.

For the Chain Stitch, bring the needle up to the right of the left thumb. Loop the thread over the thumb and back into the cloth. Then draw the needle through the loop.



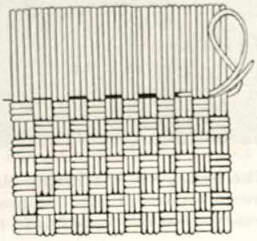


An Outline, or *Stem,* Stitch uses tiny diagonal strokes close together. Working from left to right, the needle inserts at the lower right corner, and emerges at the upper left.



For Italian Hemstitching, make parallel groups of thread, pulling two threads up, then leaving four down. Using the hemstitch, sew in and out of the clusters and the outer edge.

To Make a Plaited Stitch, lay vertical threads close together across an embroidery hoop. Then, working from right to left, weave the needle over and under 3 or 4 of the foundation threads. It is important to keep an even stitch.



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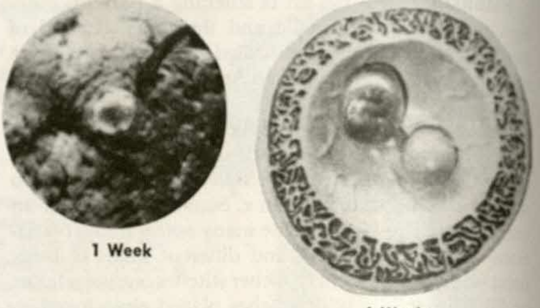
EMBRYO, *EM brih oh,* is an animal or plant that is in the very first stages of development. This name is given to the human being during the first two months of development. From this time until he is born, the human being is called a *fetus*, or *foetus*.

Fertilization. The embryo of higher animals and man comes into being when a male sex cell, or *sperm* cell, unites with a female sex cell, or *egg*. The fertilized egg that results grows and divides into trillions of cells to form the embryo and finally the fully formed young animal or baby. The embryo, which may be only $\frac{1}{4}$ inch long, grows from an egg so small it is just visible.

The fertilization of the egg cell by the sperm cell takes place in the *uterine* tube. The fertilized egg moves down the uterine tube until it reaches the *uterus*, dividing to make a ball of cells, which becomes an embryo.

The Placenta. The developing embryo remains free in the cavity of the uterus for about three days and then attaches itself to the wall of the uterus. Soon after the embryo becomes imbedded in the wall, a structure called the *placenta* forms. The placenta consists of tissues from both the mother animal and the embryo. It is attached to the embryo by means of a thick *umbilical cord*. The placenta is the organ through which the growing embryo obtains food. Blood vessels in the embryo go through the cord to the placenta and back to the embryo. Food, water, and oxygen from the mother animal are absorbed into the placenta. From it they flow into the blood vessels of the cord, and are taken to the growing embryo. Waste materials from the embryo, in turn, are carried to the placenta, absorbed into the mother's blood stream, and eliminated by the mother's kidneys.



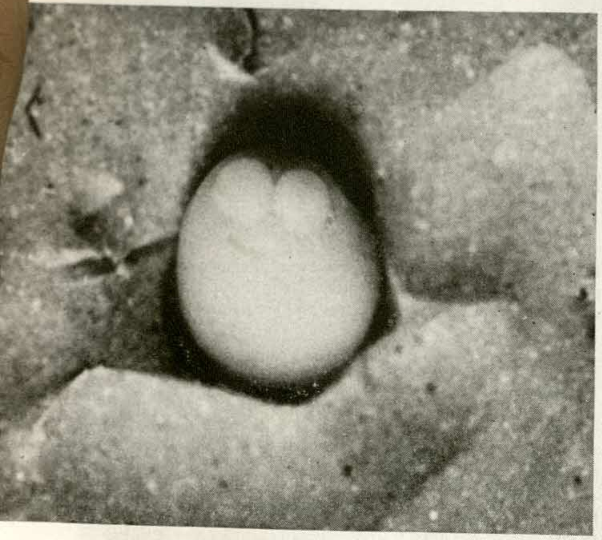
1 Week

4 Weeks

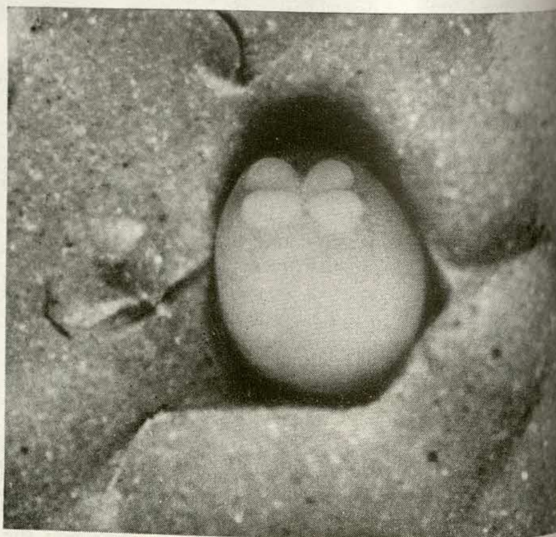
A Human Being Is Called an Embryo during the first two months of development. An embryo comes into being when a male sex cell, or *sperm*, unites with a female egg. The fertilized egg then becomes implanted in the uterus wall where it begins to develop, *left*. The placenta, on which the embryo feeds, also begins to form. At four weeks, *right*, the embryo is $\frac{1}{5}$-inch long.

Development of the Embryo. The developing embryo at first is only a small ball of cells called a *blastula*. Later the ball of cells develops a cavity within it near one side. Two more cavities then form within the thick inner cell mass. One is the *yolk sac*, the other is the *amniotic sac*. The cells of the double layer that separates these two cavities are the only ones that develop into the individual. The double layer of cells in the center of the embryo soon develops a third layer between the first two. The first two layers are called the *ectoderm* and *endoderm*. The middle layer is the *mesoderm*. All creatures from the earthworm to man consist of these three layers in the early stages of development. Each layer gives rise to the same organs in each creature. The heart and brain are formed first. The mesoderm forms the heart and circulatory system, the muscles, bones, tendons, kidneys, and reproductive organs. The brain and nervous system, skin, and outside structures develop from the ectoderm. The lining of the digestive tract and certain internal organs develop from the endoderm.

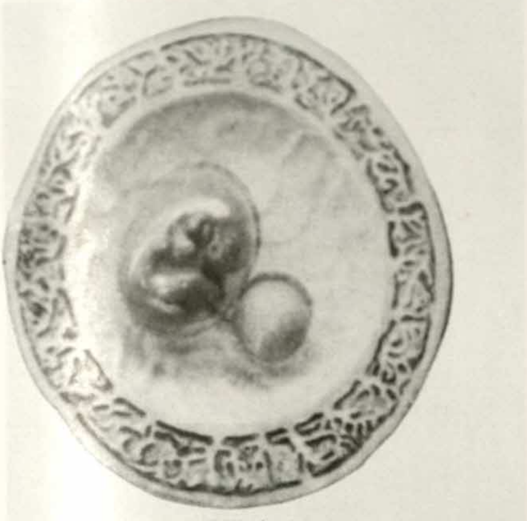
At the end of one month, the embryo of most of the



The Embryo of the Tilapia Fish develops in its father's mouth from a one-celled egg. The protoplasm at the tip of the egg becomes two cells when it is an hour old.

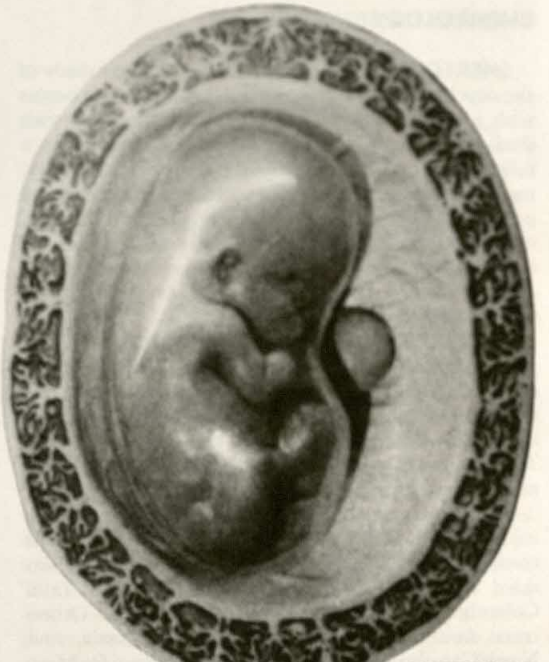


After Two Hours' Growth, each of the two cells has divided again, making four cells. The yolk, which makes up most of the $\frac{1}{8}$-inch-long egg, supplies food for the growing embryo.



5 Weeks

The Growing Embryo is $\frac{1}{3}$-inch long at five weeks, *above*. The fluid-filled sac that has formed around it acts as a shock absorber during pregnancy. At eight weeks, the embryo is 1 inch long, *right*. Its features are recognizably human at this stage. The simple beginnings of all the organs are also present, but a great deal of growth must take place in the next 7 months.



Museum of Science and Industry, Chicago

8 Weeks

higher animals and man is soft and small and about $\frac{1}{4}$ inch in length. It has a pointed, short tail curved around the belly. The head is deeply bent down. On the sides of the body there are only *buds*, or swellings, which will develop into limbs. There is a large bulge in the body wall over the heart. The mouth consists of a large hole with a short bar below it, the lower jaw. There are many blocks of tissue, called *somites*, along the back of the embryo. These will develop into muscles. On each side of the neck of the embryo are four shallow grooves that resemble the "gill slits" of fishes, and suggest that the higher animals and the fishes had a common ancestor. STEPHEN CULVER WILLIAMS

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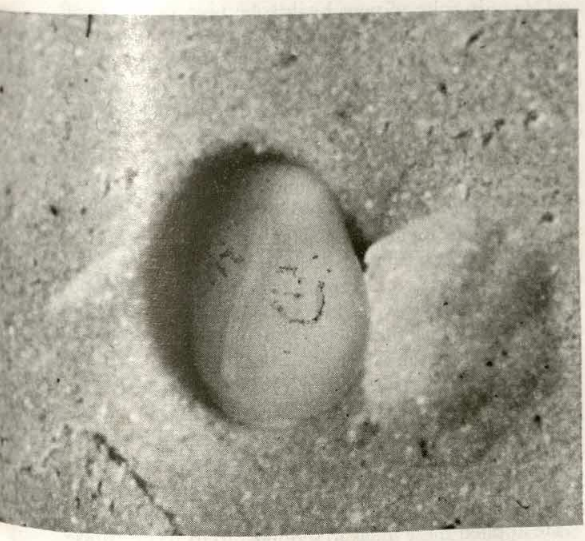
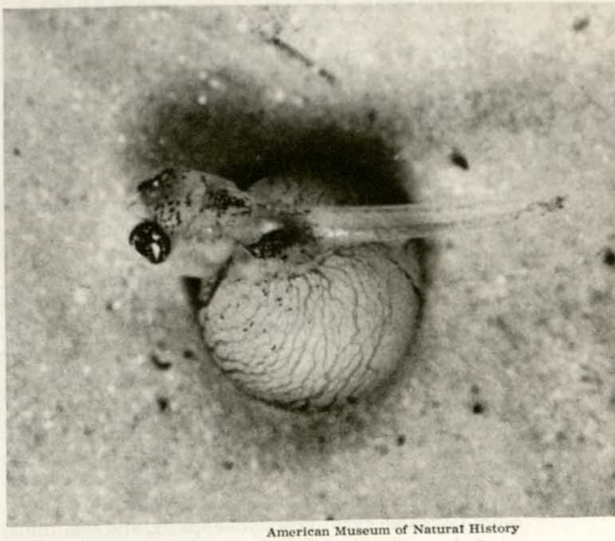


At Two Days, a slender bar, broader at the head end, appears. This shapes into eyes, ears, nerve cord, and digestive system. Black pigment cells on the yolk give color to the adult fish.



American Museum of Natural History

Seven Days after the sperm first penetrated the egg, the young fish breaks out of its shell. It spends the next eight or nine days feeding on the yolk, and then leaves its father's mouth.

EMBRYOLOGY, *em bree AHL oh jee,* is the study of the development of the young animal or plant. It begins with a study of the processes of fertilization and then deals with the development of the fertilized egg to a fully formed young animal. In the study of embryology, man is usually most concerned with a study of the higher animals. The animals commonly studied are the frog, chick, and pig. Zoologists, nurses, and medical students study embryology. [illegible]

See also Anatomy; Biology; Embryo; Evolution (Embryology); Fertilization.

EMBRYOPHYTE, *EHM bree oh FYTE,* is any one of a group of plants that develop embryos during the process of reproduction. The embryophytes make up one of the two *subkingdoms, or groups,* into which all plant life is divided. The other group is the thallophytes (see Thallophyte). Mosses, ferns, club-mosses, pines, and all flowering plants are embryophytes.

EMERALD is a rich green stone that is a variety of the mineral beryl. Large and perfect emeralds are about as costly as diamonds. The emerald has a natural six-sided form. The finest emeralds are obtained from Colombia, the largest producer of these gems. Others come from Southern Rhodesia, India, Russia, and North Carolina. The emerald is the birthstone for May.

One of the largest emeralds ever found was about the size of an ostrich egg. The people of Manta, Peru, worshiped this gem as the *Mother of Emeralds.* An emerald that weighs more than 6 pounds has been discovered, and now is displayed in a museum at Leningrad.

The *oriental emerald* is a variety of the mineral corundum. Frederick H. Pough

See also Beryl; Birthstone; Corundum; Gem.

EMERALD ISLE is a poetic name given to Ireland. It is said to have been used first by Dr. William Drennan (1754-1820) in the following stanza of his poem *Erin*:

Arm of Erin, prove strong, but be gentle as brave,
And, uplifted to strike, still be ready to save;
Nor one feeling of vengeance presume to defile
The cause or the men of the Emerald Isle.

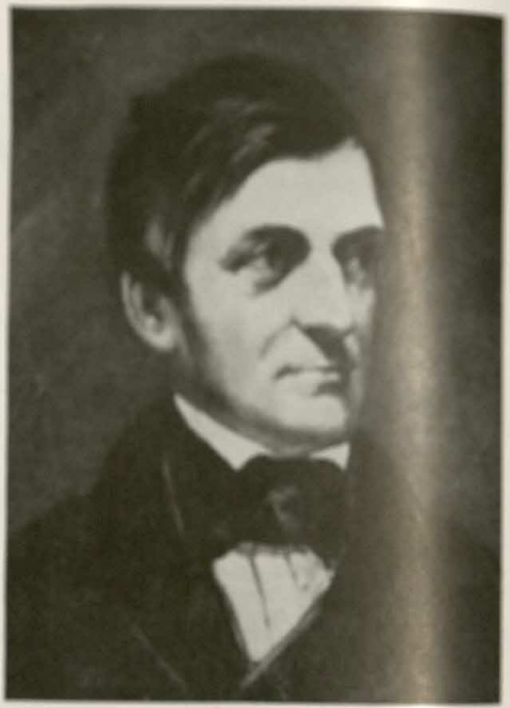
The name was given to Ireland because of its velvety green vegetation.

See also Ireland; Northern Ireland.

EMERSON, RALPH WALDO (1803-1882), was an American essayist, poet, and thinker. He wrote, he said, "to awake in man and to raise the feeling of his worth." His writings have given many readers new courage to be themselves. He inspired the American authors Henry David Thoreau and Walt Whitman, the American philosopher William James, the British author Matthew Arnold, and the German philosopher Friedrich Nietzsche. Emerson expressed his teaching in his own life.

To own many things or to be popular, he believed, does not matter. "The one thing in the world, of value, is the active soul." Each man must think for himself and act on his own best instincts. In the closing lines of his essay on "Self-Reliance" he wrote:

"A political victory, a rise of rents, the recovery of your sick or the return of your absent friend, or some other favorable event raises your spirits, and you think good days are preparing for you. Do not believe it. Nothing can bring you peace but yourself. Nothing can bring you peace but the triumph of principles."



Concord Free Public Library, Concord, Mass.

Ralph Waldo Emerson, American essayist and poet, had a philosophy of self-reliance and individual freedom.

Early Years. Emerson was born in Boston on May 25, 1803. His father, a scholarly minister of the Unitarian Church, died when Ralph was eight. His mother, though poor, managed to put young Emerson and three brothers through Harvard College. After he was graduated in 1821, he taught school and studied theology. In 1826, he was licensed to preach as a Unitarian minister, and soon, in spite of poor health, he became pastor of an important church, the Second Church of Boston. He was deeply spiritual, but also independent. Some of the church procedures troubled him, and in 1832 he resigned his position. His first wife, Ellen Tucker, had died in 1831.

Emerson made his first trip to Europe in 1833. There he met several famous authors, including the poets Samuel Taylor Coleridge and William Wordsworth, and, above all, the essayist Thomas Carlyle, who became a lifelong friend. In 1834, Emerson moved to Concord, Mass., and began his career as a lecturer and writer. He married Lydia Jackson, and became a friend of such notable neighbors as Thoreau, Nathaniel Hawthorne, and Bronson Alcott.

Lectures and Essays. From 1834 to 1841, Emerson gave regular courses of lectures in Boston and neighboring places on his philosophy of life. He published his first book, *Nature,* in 1836. It expresses his love for the natural scenes around his home, and counsels men to grow to a greatness worthy of nature.

He applied these ideas to scholarship in "The American Scholar," a lecture which he delivered at Harvard in 1837. Oliver Wendell Holmes called it "our intellectual Declaration of Independence." In it, Emerson advised his hearers to learn directly from life, then to know the past through books, and finally to express themselves in action. The lecture contained new ideas for the times, and was so opposed at Harvard that Emerson was not asked there again for 30 years.

In later years, Emerson traveled through the northern and western parts of the United States lecturing. In 1847 and 1848, he went on a lecture tour of England. Most of his essays are based on his lectures.

The first series of his *Essays* (1841) includes some of his best known, such as "Self-Reliance." In 1844, a second series was published which contains perhaps his finest, "Experience." By this time, Emerson had become associated with that group of New England idealists known as Transcendentalists (see TRANSCENDENTALISM). For a short time, he edited their publication, *The Dial*. In 1846, his first volume of poems was published. The next year's trip to England resulted in *English Traits* (1856), a brilliant travel book. Other important works include *Representative Men* (1850) and *The Conduct of Life* (1860).

Poetry. Emerson's poems, like his essays, are reflective and serious. Among them are some of the best poems in American literature, such as "The Snow-Storm," "Uriel," "Days," and "Brahma." His stirring "Concord Hymn" was sung at the completion of the Battle Monument at Concord in 1837. The first stanza, which follows, is inscribed at the base of the statue of the minuteman at Concord (see MINUTEMAN [picture]).

By the rude bridge that arched the flood,
Their flag to April's breeze unfurled,
Here once the embattled farmers stood,
And fired the shot heard round the world.

Last Years. Emerson was continually before the public as a writer and lecturer until about 1870, when his health began to fail. His last years were spent quietly at Concord and he did little writing. He was buried in Sleepy Hollow Cemetery in Concord, near the grave of Nathaniel Hawthorne. STEPHEN E. WHICHER

EMERSON COLLEGE is a privately controlled coeducational school of speech education at Boston, Mass. The school was established in 1880 as Boston Conservatory of Oratory. It adopted its present name in 1939. Courses lead to B.A. and B.S. degrees. For enrollment, see UNIVERSITIES AND COLLEGES (table).

EMERY is a rock used to grind metals, gems, and optical lenses. It contains several hard minerals. Corundum, the most abundant mineral in emery, is one of the hardest of all natural substances, next to diamond (see CORUNDUM). Emery is crushed into small grains or a fine powder. It may then be mounted on paper or cloth or be mixed with cement and formed into grinding wheels. It may also be used directly on polishing laps (see GRINDING AND POLISHING [Lapping]). Emery is mined in Russia and on the islands of Naxos and Samos in the Aegean Sea. The United States has deposits near Chester, Mass.; Peekskill, N.Y.; and in Virginia. Manufactured abrasives such as aluminum oxide and silicon carbide have been replacing emery. See also ABRASIVE. ERNEST E. WAHLSTROM

EMETIC, *ee MEHT ick*, is a drug or other substance which produces vomiting. It acts indirectly on the throat and stomach, or may directly stimulate the vomiting center in the *medulla*, the lower part of the brain. When vomiting is induced, nerve impulses pass to the muscles of the stomach wall, and cause them to contract and push out the contents. An emetic is used to rid the stomach of certain foods or poison. It is also given in diphtheria to relieve the air passages of mucus. Two tablespoons of mustard in a pint of water can be given as an emetic. A tablespoon or more of salt with enough lukewarm water to be swallowed also can be given. An emetic should not be given to one who has taken a corrosive poison. See also ANTIDOTE. [illegible]

EMETINE. See IPECAC.

EMIGRATION. See IMMIGRATION AND EMIGRATION.

ÉMIGRÉ, *ay mi GRAY*, was a person who fled France because of the French Revolution. The emigration began after the fall of the Bastille on July 14, 1789. The first *émigrés* were clergymen or nobles who feared for their lives. Outside of France, they became important in stirring up other governments against the Revolutionary government in France. In 1792, an Austro-Prussian army invaded France. The *émigrés* persuaded its commander, the Duke of Brunswick, to threaten to level Paris if the captive King Louis XVI was harmed. The declaration led the Parisians to depose the king and to organize a "commune" which held effective power for over a month. It also caused them to summon a convention to give France a new constitution. As the Revolution became more radical, some moderate revolutionaries emigrated. Among them were Lafayette and Lazare Nicolas Carnot, a statesman.

Napoleon Bonaparte granted the *émigrés* a general pardon when he became ruler of France. Some *émigrés* who did not return, including members of the royal Bourbon family, conspired against Napoleon. Their land was confiscated and their relatives became subject to arrest. When the Bourbons returned after Napoleon's fall, the *émigrés* wanted their land back. But in 1825 they received money payments instead of the land. ROBERT B. HOLTMAN

See also FRENCH REVOLUTION.

EMIN PASHA, *eh MEEN pah SHAH* (1840-1892), a German explorer, became famous for his work in Africa. He was born Eduard Schnitzer, in Oppeln, Prussia. He studied medicine at Königsberg, Germany, and became a surgeon in the Turkish Army. There he adopted the name *Emin*, meaning *faithful one*.

In 1876, he entered the Egyptian service as *pasha*, or governor, of the Sudan. While exploring the upper Nile in 1883, he was cut off from civilization by a native uprising. Sir Henry Morton Stanley, who was already famous for finding David Livingstone, rescued Emin in 1888 (see STANLEY AND LIVINGSTONE). Emin returned to Africa and went on an expedition for the German East Africa Company. He was murdered by tribesmen at Stanley Falls, on the upper Congo River. FRANKLIN L. FORD

EMINENT DOMAIN is the inherent right of a state to force a property owner to sell his property when it is needed for public use. The legal process of taking over property which the owner has refused to sell is called *condemnation*. Federal, state, and local governments in the United States, and sometimes private corporations, have the right of eminent domain. Public improvements involving right of eminent domain include the construction of harbors, canals, fortifications, and roads.

Land also may be taken over in this way for public schools, asylums, municipal buildings, and housing projects. The state may allow private agencies in which the public is interested, such as railroad companies and power plants, to use the right of eminent domain. If a railroad surveys its route for a right of way, and an owner of property refuses to sell, the railroad may bring court proceedings. The court may then appoint an appraiser to set a fair price for the land or ask a jury to determine the price (see APPRAISAL). WILLIAM TUCKER DEAN

EMIR, *uh MEER,* or **AMIR,** is a Moslem title of nobility, often used as the title of a ruler of an Islamic country.

EMMANUEL COLLEGE is an arts and sciences school for girls in Boston, Mass. It is conducted by the Sisters of Notre Dame of Namur of the Roman Catholic Church. Courses offered include languages, sciences, music, and education. Emmanuel College was founded in 1919. For enrollment, see UNIVERSITIES (table).

EMMANUEL MISSIONARY COLLEGE is a coeducational liberal arts school at Berrien Springs, Mich. It is controlled by the Seventh-Day Adventist Church, but students of other faiths are admitted. Courses lead to B.A. and B.S. degrees. An industrial program offers work opportunities to most of the students. The college was founded in 1874. For enrollment, see UNIVERSITIES AND COLLEGES (table). F. O. RITTENHOUSE

EMMANUEL MOVEMENT tried to apply psychology to religious problems. It was named after Emmanuel Church in Boston. Elwood Worcester, pastor of the church, and Samuel McComb, his assistant, began the movement. They formed a class for tubercular patients in 1905, and later extended their work to the mentally ill. The patients read from the Scriptures and prayer book, and also received mental treatment. Both founders had studied psychology, and Worcester had taught it at Lehigh University. ALBERT E. AVEY

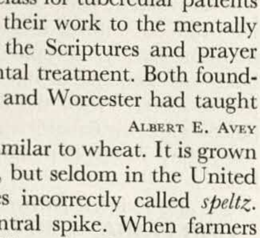
EMMER is a cereal grain similar to wheat. It is grown in some European countries, but seldom in the United States. Emmer is sometimes incorrectly called *speltz.* This grain has a brittle central spike. When farmers thresh the emmer, stiff leaflike parts that enclose the grain remain. The hulls may be either white or black. Emmer is used as food for livestock.

Scientific Classification. Emmer belongs to the grass family, *Gramineae.* It is genus *Triticum,* species *dicoccum.* ROY G. WIGGANS

EMMET, ROBERT (1778-1803), an Irish patriot, became one of that country's best-remembered heroes. He led an unsuccessful revolt against the English viceroy in 1803. Although he escaped after the revolt, he was later captured, tried, and hanged. Emmet was born in Dublin of a good family. As a young man, he became disturbed over the injustice of English rule. He joined the United Irishmen, and later sought assistance in France in an effort to free Ireland. He then organized his own revolt. CHARLES F. MULLETT

Robert Emmet

BROWN BROS.



EMMETT, DANIEL DECATUR (1815-1904), an American minstrel performer and song-writer, wrote "Dixie" (1859). It became the war song of the South in the Civil War. He wrote many other songs, including "Old Dan Tucker." Emmett was born in Mt. Vernon, Ohio, and enlisted in the army as a fifer when he was 17. He also learned to play the violin and the flute. He joined Bryant's Minstrels, for whom he wrote "Dixie," in 1859. He made his last public appearance in 1896. See also MINSTREL SHOW. GILBERT CHASE

EMORY AND HENRY COLLEGE is a coeducational liberal arts school located in a broad mountain valley at Emory, Va. It is controlled by the Methodist Church. Courses offered lead to B.A., B.S., and B.Ed. degrees. The college was founded in 1836. For enrollment, see UNIVERSITIES AND COLLEGES (table).

EMORY UNIVERSITY is a coeducational school at Atlanta, Ga., affiliated with the Methodist Church. It includes a College of Arts and Sciences, a Graduate School, and schools of business administration, dentistry, law, medicine, nursing, and theology. There is a junior college at Oxford, Ga. The university has an Air Force R.O.T.C. unit. Emory was founded in 1836 as Emory College, at Oxford. The university was chartered in 1915, and organized at Atlanta. For enrollment, see UNIVERSITIES (table). R. F. WHITAKER

EMOTION includes the states commonly referred to as anger, joy, love, grief, and fear. Many emotions are accompanied by physical disturbances.

Emotions are classified in various ways. Some psychologists believe that all emotions stem from three basic emotions: fear, anger, and love. Thus anxiety and alarm are the result of *fear*, annoyance and irritation are forms of *anger*, and tenderness and sympathy are expressions of *love*. All emotions are reactions to causes called *stimuli*. Stimuli may be inward mental events, as well as outward physical events. For example, remembering certain words may call forth the same sensation of joy as hearing them did in the first place.

Emotion and Instinct. Some psychologists believe that all emotions are based on instinct (see INSTINCT). Most human beings and many animals react emotionally in much the same ways when they are faced with the same conditions. A kitten or young baby will struggle and become angry if it is held so tightly that it cannot move. It shows love and pleasure when it is petted.

Pleasant and Unpleasant Emotions. There are in general two groups of emotions, caused by two types of situations. When the individual is kept from gaining what he wants or doing what he wants to do, he is said to be thwarted or *frustrated.* He reacts to frustration with emotions such as anger, fear, and hate. These are all unpleasant emotions, and may lead to a feeling of insecurity, both physical and social. Pleasant emotions such as joy or love are an individual's reactions to conditions and events that help him reach his goal or get what he wants.

Emotions and Their Physical Expression. A person reacts to emotion by certain types of physical behavior. Both pleasant and unpleasant emotions depend on this physical expression. Thus, laughter or a smile often is a part of the emotion of joy. A clamped jaw, curled lip, and clenched fist may be the body's expression of the emotion of anger. Sobs and tears often evidence grief. Intense fear is expressed by a shortened breath, fast-

Harold M. Lambert; Dorothy McLaughlin, A.P.A.; Richard Hewett, Globe Photos; Suzanne Szasz; Walter Chandoha

Five Basic Emotions, Expressed Here by Children, Are, *left to right,* Joy, Anger, Love, Fear, and Grief.

beating heart, and tense expression. Man can learn to control these outward expressions of his emotions. But in controlling them he is also controlling or changing the emotion itself to some extent.

Emotion and Bodily Changes. Emotions like pain, fear, hate, anger, and rage cause much the same changes in the way the body functions. The heart beats faster, the face flushes, the breathing speeds up, and the blood pressure rises. The muscles become tense, and a chemical change takes place in the blood. Some of the blood supply goes from the internal organs to the muscles and brain. The adrenal glands become more active.

If the emotion lasts long enough, the thyroid gland also speeds up its activity. The liver sends stored energy into the blood stream, so that the muscles can use it. The digestive processes slow down or stop entirely, and the person's mouth becomes dry because of the lack of saliva. These changes distribute the body's energy in such a way that it is ready for action, and in most cases can protect and defend itself better.

When an emotional state of this kind is continued or repeated, however, the body may be harmed. A state of anxiety or worry hurts digestion and may result in indigestion, poor appetite, or stomach ulcers. Scientists believe that some diseases may be caused by states of emotion that result in chemical changes in the body.

Emotion and Personality. Emotional patterns have a great deal to do with an individual's success in meeting his personal problems. Differences in personality are to some extent differences in patterns of emotional behavior. People's interests depend on their emotions. Usually, they prefer subjects connected with goals which have strong emotional appeal. Whole systems of psychology have been built around the emotions of love and hate, dominance and submission, sex interests, or combinations of these factors.

An individual does not always recognize either his emotions or their causes. The body and the personality have needs and cravings that remain far below the level of the conscious mind. Emotional patterns may be connected with events that occurred long ago and have been forgotten. Thus a person may be depressed by an event that reminds him of a forgotten emotional reaction.

Frustration. Some people claim that frustration must be avoided because it results in unpleasant emotional states. This is not true. If a state of anxiety or some other destructive emotion is allowed to continue for a long time, it may harm the personality and the body. But that does not mean that the human being should never experience unpleasant emotions. The personality has to know disappointment and pain, as well as joy and pleasure. This is a part of the process of growth. A child who has been protected from all conflict will never become a well-adjusted human being. RAYMOND H. WHEELER

See also ANGER; COLOR (The Human Side of Color); FEELING; PERSONALITY; PSYCHOLOGY.

EMPATHY, *EM puh thih,* is the ability to know how another person thinks or feels. We have no direct knowledge of the state of mind of anyone but ourselves. But we can often guess accurately what someone is thinking. Such empathy may be based on small hints that we are not aware of. Sometimes people do not really feel empathy. They *project,* or attribute to others, the traits that they have themselves. Children often attribute feelings to inanimate objects such as toys. Psychologists also call this empathy. RUSSELL M. CHURCH

EMPEDOCLES, *em PED oh klees* (495?-435? B.C.), a philosopher of Greek descent, wrote a poetic treatise *On Nature.* It contained ideas that foreshadowed later knowledge of evolution, the circulation of the blood, and atmospheric pressure. He was born and lived in Sicily, and is sometimes regarded as the founder of Italian medicine. He also wrote *On Purifications,* which contained religious teachings. LEWIS M. HAMMOND

EMPENNAGE. See AIRPLANE (Tail Assembly).

EMPEROR, *EHM pur ur,* is the ruler of an empire, or group of nations or states. A *king* usually rules only one area or people, but an emperor rules several. The word comes from the Latin word *imperator,* meaning *commander.* It represented a military command in early Roman times, but later came to be the title of a ruler. After the fall of the Roman Empire in the West, in A.D. 476, the title of emperor passed out of use in Europe for several hundred years. In A.D. 800, Charlemagne had himself crowned Emperor of the Holy Roman Empire. In 1806, this empire came to an end. Since 1800, emperors have ruled China, France, Germany, Japan, and Russia at one time or another. The wife of an emperor or a woman who rules an empire is called an *empress.* ROBERT S. ROGERS

See also EMPIRE; IMPERATOR.

EMPIRE is a domain made up of different countries or states, held together and ruled by the strongest nation in the group. The word comes from the Latin word *imperium,* which means a *dominion* or a *command.* History has seen the rise and fall of many great empires, such as those of Egypt, Rome, Germany, and Japan. In modern times, Great Britain, The Netherlands, France, and other countries built up colonial empires. See also EMPEROR. J. SALWYN SCHAPIRO

EMPIRE DAY. See VICTORIA DAY.

EMPIRE STATE. See NEW YORK.

EMPIRE STATE BUILDING is the tallest skyscraper in the world. It is located at 350 5th Avenue in New York City. The building has 102 stories, and reaches an amazing height of 1,250 feet. A 222-foot television tower brings the total height to 1,472 feet, or more than a quarter of a mile high. Four powerful beacons called the *Freedom Lights* shine from the top of the building, and can be seen as far away as 80 miles.

The Empire State Building was completed in 1931 at a cost of $52,000,000. It contains 6,500 windows, 1,860 steps to the 102nd floor, 350 miles of telephone and telegraph cables, and 60 miles of water pipes. It houses 10,000 tenants, and receives 20,000 business persons every day. Each year over 1,500,000 persons visit the building's two large observatories on the 86th and 102nd floor. People sometimes see it raining below them while they are in sunshine. During a storm, the building absorbs as many as 20 bolts of lightning. The building's steel structure creaks slightly when heavy winds cause it to sway. The greatest sway was 1.45 inches from center, which occurred during a 100-mile-an-hour wind.

See also NEW YORK CITY (picture, Towering Skyscrapers).

EMPIRE STATE OF THE SOUTH. See GEORGIA.

EMPIRICISM, *ehm PIHR ih sizm*, is a philosophy that accepts sense experience as the only trustworthy source of knowledge. An empiricist relies on observation and experimentation in deciding what is true. He arrives at conclusions by using the *inductive method*, based on what he has observed (see INDUCTIVE METHOD). A *rationalist* stresses reason as the source of knowledge. He begins with *a priori*, or self-evident, principles, and uses the deductive method (see DEDUCTIVE METHOD).

The English philosopher John Locke expressed the empirical view. He spoke of the mind as a blank tablet upon which experience writes. Empiricists may differ greatly in their outlooks. Idealists like Bishop George Berkeley of Ireland, materialists like the French philosopher Denis Diderot, and pragmatists like the American philosophers William James and John Dewey can all be called empiricists. H. M. KALLEN

The WORLD BOOK has separate articles on each of the philosophers mentioned. See also IDEALISM; MATERIALISM; PRAGMATISM; RATIONALISM.

EMPLOYEES' COMPENSATION, BUREAU OF, was created in 1946 to administer the federal laws establishing the workmen's compensation program for employment within federal jurisdiction. It was established in the Federal Security Agency but was moved to the Department of Labor in 1950.

The laws this bureau supervises include those that provide benefits for employees of the United States who suffer personal injury while on duty. The bureau also administers the Longshoremen's and Harbor Workers' Compensation Act, which provides benefits to employees in private enterprise while they are engaged in maritime employment. It determines the benefits to be received, and makes the arrangements for them. An Employees' Compensation Appeals Board acts as the final judge if the employee is not satisfied with the decision of the bureau. JOHN C. BOLLENS

EMPLOYERS' ASSOCIATION. See TRADE ASSOCIATION.

EMPLOYERS' LIABILITY. See WORKMEN'S COMPENSATION.

EMPLOYMENT is an occupation, trade, or profession carried on for the purpose of receiving compensation. Compensation may be in the form of wages, salaries, commissions, fees, or profits. Most compensation is in the form of money, but some may be in the form of goods or services. For example, some domestic servants and some farm hands receive food and lodging as a part of their payment. For any work to be considered employment, it must be for the purpose of receiving compensation. A professional athlete is considered to be employed because he receives money. An amateur athlete is not. A person who operates his own business or profession is said to be *self-employed*.

Total Employment is a term used to refer to the number of persons who are employed. In the late 1950's, total employment in the United States stood at more than 67,000,000. In general, total employment tends to rise when business, industry, and consumers spend or invest more widely. It tends to fall when more organizations and individuals save their money. When spending and saving remain about equal, employment tends to remain at about the same level. This may be a high or a low level, depending on what has happened before.

Stimulating Employment. Many economists argue that when reduced spending and investment threatens to reduce national income and employment, the government should increase its spending to counteract this *deflationary gap*. They feel such increased spending helps the economy even if the government uses *deficit spending*, or spends more money than it takes in.

A government program of deficit spending can be operated in either of two ways. The government may keep its tax rates, or income, the same and finance increased public works by borrowing the money. Or, it may keep its expenditures unchanged, decrease taxes, and make up for the reduced income by borrowing.

If the government increases public works, employment increases because more workers are needed. If it reduces taxes, taxpayers have more money to invest, and employment also increases. But a public works program takes time to start, and cannot be stopped abruptly when the economy recovers. Decreasing taxes, on the other hand, is not as efficient in raising employment, because many taxpayers may save, rather than invest, their extra money.

Many economists agree that a government can spend its way out of a period of depression. The real problem is whether it can rigidly hold down inflation, or prices, when full employment is reached. ALBERT L. MEYERS

See also INFLATION AND DEFLATION; LABOR; UNEMPLOYMENT; VOCATIONAL GUIDANCE; WAGES AND HOURS.

EMPLOYMENT AGENCY brings together persons seeking employment and employers who wish to add to their working staff or to make replacements. Employment agencies are particularly useful in large cities, where a person seeking work might not be able to locate easily those employers who have job openings. An employment agency keeps in close contact with a number of business firms. It is informed when one of these firms needs workers. The agency then selects persons from among those who have come to it seeking employment. It arranges interviews between the job-seekers and the employers. The employment agency keeps files of information about the educational background, experience, and skill of various job seekers.

Private employment agencies now usually charge the employer a fee for finding workers. Agencies base the fee on the salary to be paid. This practice started during World War II when there was a great shortage of workers. Sometimes the worker pays the fee.

The federal government created the United States Employment Service during World War I to operate free employment bureaus. The United States Employment Service declined after that war but was revived and expanded in 1933. Under the Social Security Act of 1935 all the states operated free employment offices in connection with their systems of unemployment compensation. During World War II, these state employment offices were operated by the U.S.E.S. in all important cities and towns of the United States.

Many institutions such as universities, professional organizations, and branches of the YMCA and the YWCA often have job placement bureaus. ROBERT D. PATTON

See also EMPLOYMENT SECURITY, BUREAU OF; UNEMPLOYMENT.

EMPLOYMENT INTERVIEW. See VOCATIONAL GUIDANCE (How to Get the Job You Want).

EMPLOYMENT SECURITY, BUREAU OF, is responsible for managing the public employment service and the unemployment insurance programs of the United States government. The bureau is an agency of the Department of Labor in Washington, D.C. It maintains regional offices in 11 major cities in the United States.

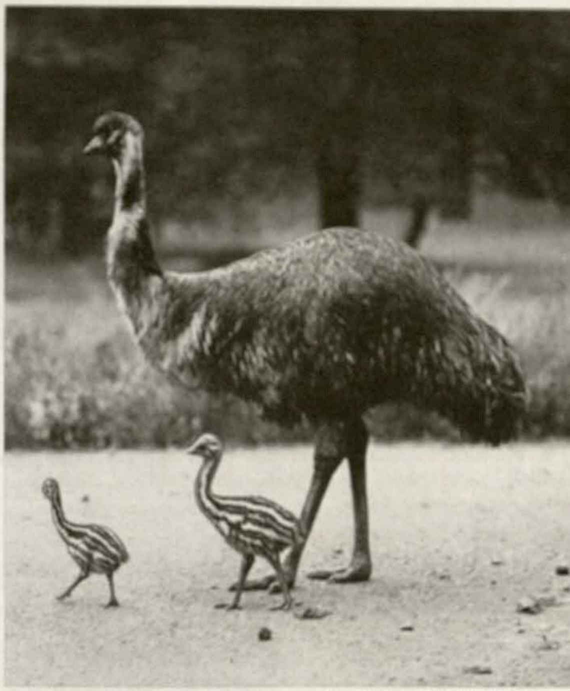
The bureau operates four services. Three of them operate under the name of the United States Employment Service. The employment service is a national system of public employment offices. These offices are set up by the state, but receive federal aid.

The Veterans Employment Service makes certain that veterans get special consideration in seeking employment. It has a veterans employment representative in each state. The Farm Placement Service maintains a year-round placement service for agricultural workers, and works on the problems connected with importing workers from Mexico. It also arranges for bringing in agricultural workers from Canada and the British West Indies. The fourth unit of this bureau is the Unemployment Insurance Service. This office cooperates with the states in the details of unemployment insurance under the social security program. See UNEMPLOYMENT INSURANCE. JOHN C. BOLLENS

EMPORIA, COLLEGE OF, is a coeducational institution of arts and sciences at Emporia, Kan. It is controlled by the Presbyterian Church. Graduates receive B.A., B.S., B.Mus., and B.M.E. degrees. The college was founded in 1882 by the Presbyterian Synod of Kansas. For enrollment, see UNIVERSITIES AND COLLEGES (table).

EMPRESS. See EMPEROR.

EMU, *EE myoo,* is a large Australian bird that cannot fly. It stands more than 5 feet high. The only larger bird is the ostrich. The emu is a relative of the cassowary, and like it has three toes. But it is unlike the cassowary in other ways. Its head does not have a bony crest, or helmet. It has many feathers on its head and neck. The emu has blackish or brown plumage. The plumage is also thick, because two plumes grow from each quill. The wings are hidden in the plumage.



New York Zoological Society

The Australian Emu has tiny wings that are useless for flying. But its long sturdy legs make the emu a swift runner. The young birds lose their striped down and grow dark feathers.

The female emu lays six or seven green, rough-surfaced eggs in a shallow nest dug in loose earth. Then the male emu sits on the eggs to hatch them. He also raises the young birds. Emus eat fruit, herbs, and roots. Emus are considered pests in western Australia, where they cause great crop damage.

Scientific Classification. Emus are in the family *Dromiceiidae.* The common emu is genus *Dromaeus,* species *novae-hollandiae.* ALDEN H. MILLER

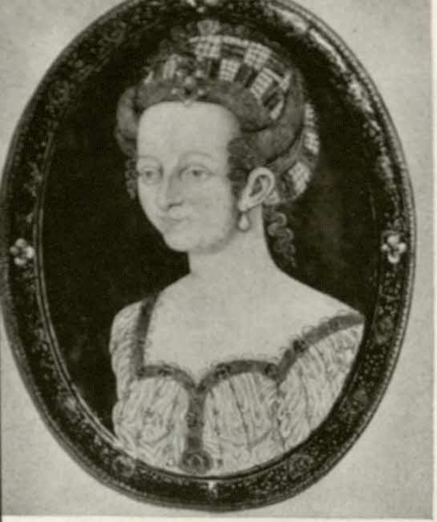
See also CASSOWARY; OSTRICH.

EMULSION, *ee MULL shun,* is a preparation of an oily substance in a liquid, or the opposite. Gravy is a common example of an emulsion. In an emulsion the oily particles do not dissolve in the liquid, but remain suspended in tiny droplets. An emulsion of some pleasant-tasting substance with disagreeable-tasting medicines such as cod-liver oil and castor oil makes the medicines much easier to take. Certain substances, such as gum arabic or egg yolk, can cause emulsion. These agents surround the small particles of oil and prevent their running together. AUSTIN EDWARD SMITH

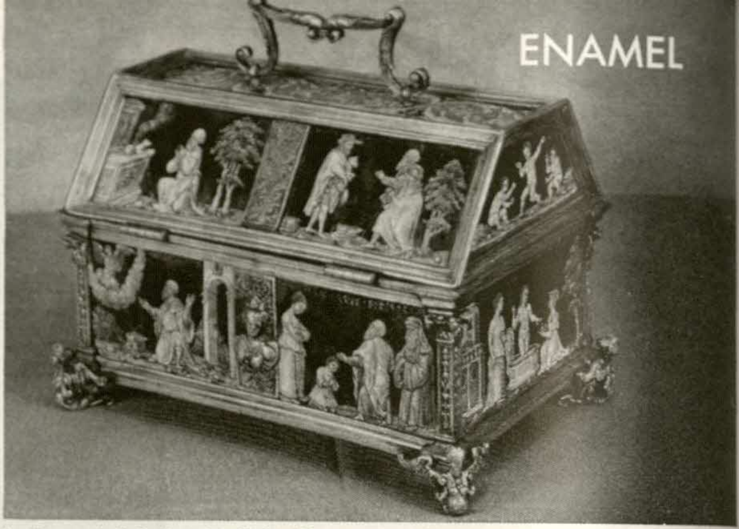
See also COLLOID; SUSPENSION.

ENABLING ACT is a law which authorizes, or *enables,* individuals or groups to do things they would otherwise have no power to do. The United States Congress passed *enabling acts* to allow territories to set up the machinery for becoming states. These acts defined the boundaries of the new states. They also gave the people of the territories the right to elect delegates, hold a constitutional convention, and draw up a state constitution. A separate enabling act had to be passed for each territory before it became a state. PAYSON S. WILD, JR.

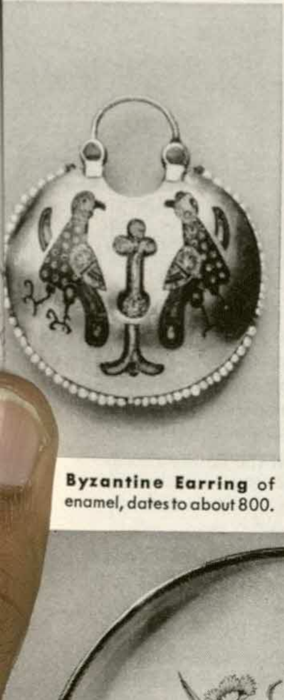
ENAMEL. See TEETH.



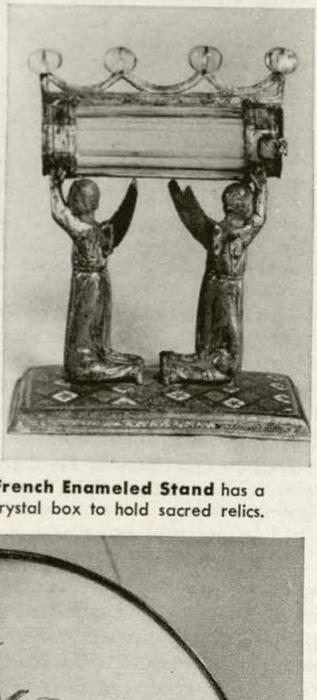
A Painted Enamel Plaque was made about 1550 at Limoges, French porcelain center.



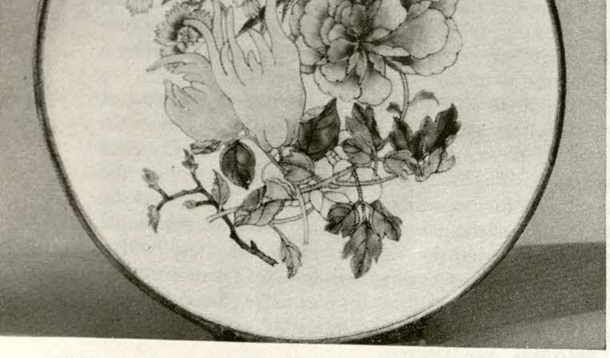
An Enameled Casket for Valuables, made at Limoges early in the 1500's, is decorated with scenes from the story of David and Solomon.



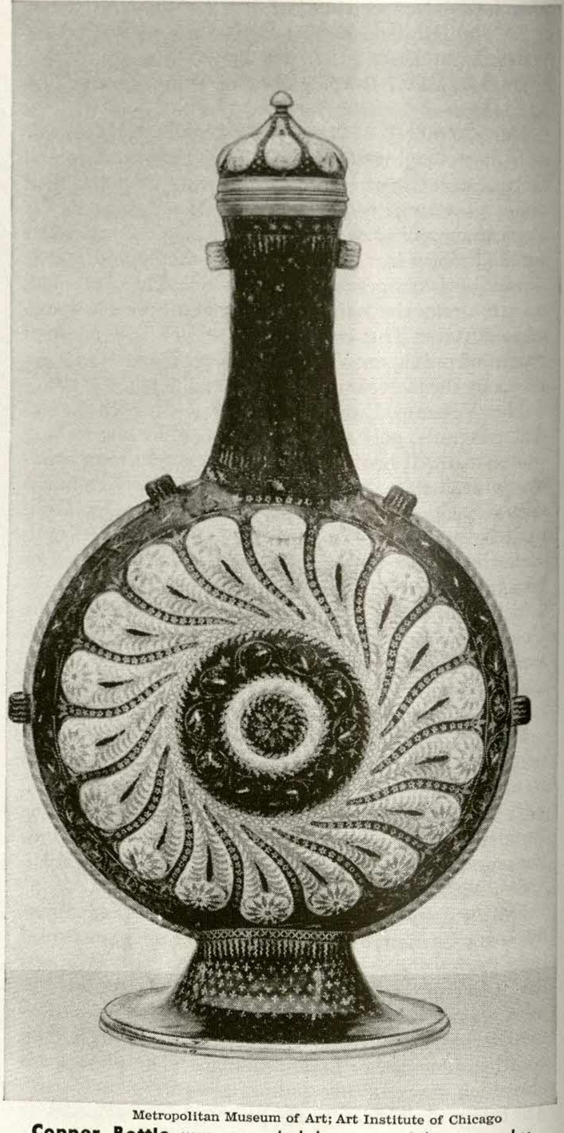
Byzantine Earring of enamel, dates to about 800.



French Enameled Stand has a crystal box to hold sacred relics.



A Chinese Enameled Plate, made during the period of the Ch'ing Dynasty. This family ruled China from the 1600's to the 1900's.



Metropolitan Museum of Art; Art Institute of Chicago

Copper Bottle was enameled by a special process by skilled workers in Venice, Italy, in the 1400's.

ENAMEL, also called PORCELAIN ENAMEL, is a glass-like substance. It may be transparent or opaque, and is produced in a variety of colors. In art work, it is used to decorate the surface of metal, glass, or sometimes pottery. Porcelain enamel acts as a protective surface for a great variety of metal products such as cooking utensils, kitchen and bathroom fixtures, and store and shop equipment. Acid-, corrosion-, and weather-resisting porcelain enamels have been produced to protect many types of industrial equipment. These include various kinds of tanks; bearings; electric insulators; chemical, mechanical, and thermal wares; and electric-motor parts. In the building-construction industry, material surfaced with porcelain enamel is used for store fronts, gas stations, and various other purposes. *Enamel* also applies to a kind of glossy paint. It contains a substance such as varnish, which, after drying, leaves a hard, glossy surface. See PAINT.

Make-Up. Enamel is made chiefly of feldspar, quartz, silica, borax, lead, and mineral oxides for coloring. After these materials are ground into fine particles, they are applied in various ways to the article to be enameled. The article is then fired at a temperature of about 1500° F. The heat melts the enamel and unites it with the surface of the article. The enamel must melt at a lower temperature than the object decorated, or the object may melt, too. Because gold, silver, and other metals, as well as glass, melt at higher temperatures than enamel, it is possible to protect and decorate them with enamel.

Glass, glaze, and enamel are all related, and the terms *glaze* and *enamel* are often used to mean the same thing. But *glaze* more often refers to a transparent coating for pottery or tiles (see PORCELAIN; POTTERY).

Decorative Enameling. When enamel is used as a decoration, it may be applied in several different ways. For *champlevé* enamel, a design is carved in metal, and the depressions are filled with the enamel. The raised lines which remain form the outline of the design. *Cloisonné* is made by bending thin strips of metal to form a design. The edges of the strips are fastened to the metal surface of the object, and the spaces between the strips are filled with the enamel.

A form of cloisonné enamel without a metal foundation is called *plique-à-jour* (see PLIQUE-À-JOUR). *Basse-taille* is an almost transparent enamel laid in thin coatings over a design engraved in metal. *Surface-painted enamels* are made by coating a metal surface with enamel on which a design is painted and then fired.

Niello is a method of ornamenting gold and silver objects such as plates. A design is first engraved on the surface. Then a metallic compound made of silver, lead, copper, and sulfur is put into the design and fired. The compound melts at a lower temperature than does the silver or gold. The surface is then smoothed and polished, and the design is left in black.

Niello was used by the Egyptians, Greeks, and Romans. It was especially popular during the period of the Byzantine Empire. Anglo-Saxon jewelry made much use of this technique. Many objects used for the Christian ritual during the Romanesque period were decorated with niello. It is still used in Russia and India.

Enameling reached its greatest heights in the Middle Ages. Limoges, France, became the best-known center. Artisans in this city made beautiful Eucharistic vessels for the Roman Catholic Church. CHARLES M. HARDER

ENAMELWARE is an article of metal coated with enamel to protect it from rust and acids and to make the surface easy to clean. The enamel is composed of glass and other minerals ground into a powder. Sometimes this powder is sprinkled on the metal while it is red hot, and the enamel melts and covers the metal with a smooth, even surface. In another enameling process, the powder is dissolved in a liquid and applied to cold metal, which is then heated red hot. Enamelware products include cooking utensils, bathroom fixtures, kitchen stoves, and refrigerators. See also ENAMEL.

ENCEPHALITIS LETHARGICA. See SLEEPING SICKNESS.

ENCEPHALOGRAPH. See ELECTROENCEPHALOGRAPH.

ENCHILADA, *EN chee LAH dah,* is a Mexican food used as the main dish of a meal. The ingredients differ in various areas. Usually they include a layer of dough made from corn flour, with a layer of cheese or ground meat on top. Chopped chili peppers and green sweet peppers are added, and the concoction is rolled together. It is baked in a hot oven or on a hot rock. Enchiladas are usually served hot, sometimes with a sauce. RICHARD A. HAVENS

ENCKE'S COMET. See COMET.

ENCLAVE is a territory of a country that is separated from that country by the territory of another country. For example, between World War I and World War II, the Polish Corridor separated East Prussia from the rest of Germany. East Prussia was an *enclave.* Countries or states without a seacoast are usually called *landlocked states,* but sometimes *enclaved states.*

In the Middle Ages, many territories belonging to one ruler were separated by territories of other rulers. Each government usually recognized a right of passage, sometimes even for armies. But modern countries do not want foreign territories within their boundaries. As a result, most enclaves have been absorbed by the countries that surrounded them.

A few enclaves remain in the world today. Since 1779, Portugal has held three small enclaves in India. When India became independent from Great Britain in 1947, it claimed the enclaves. Portugal would not give them up, so India has sometimes interfered with the passage of Portuguese goods to the enclaves. HERBERT W. BRIGGS

ENCULTURATION. See ACCULTURATION.

ENCUMBRANCE, *ehn KUM brunce,* or **INCUMBRANCE,** commonly is a debt which must be repaid before property belongs wholly to its owner. If an encumbrance is not repaid when due, the lender of the money can take the property or foreclose on it to collect his debt, depending on its nature. Property can be *encumbered,* or placed in debt, by a mortgage or lien (see LIEN; MECHANIC'S LIEN; MORTGAGE). Technically, *encumbrance* may refer to any interest or claim against property (see EASEMENT). JOHN ALAN APPLEMAN

ENCYCLICAL, *en SI klih kul,* or *en SIK lih kul,* is a letter addressed by the pope to his bishops on important questions. The encyclicals *Rerum novarum* of Pope Leo XIII in 1891, on the condition of the working classes, and *Quadragesimo Anno* of Pope Pius XI in 1931, on the reconstruction of the social order, are well known. An encyclical differs from a *bull,* which is not a directive of policy, but an official decree. See BULL. FULTON J. SHEEN

ENCYCLOPEDIA

Lars Hedman

An Encyclopedia not only furnishes the reader with information, but also stimulates him to go still further in his search for knowledge.

ENCYCLOPEDIA, *en SIGH kloh PEE dih uh*, is one or more books with information about persons, places, events, and things. It may deal with all areas of knowledge or it may confine itself to just one area. A general encyclopedia, such as The World Book, includes subjects in every field of knowledge. An encyclopedia on a specific subject, such as law or medicine, is designed to give the specialist detailed and technical information in his field.

As man learned about himself and the world in which he lived, he began to write about what he learned. This information on various subjects was scattered in thousands of manuscripts and books in various parts of the world. As a result, it was difficult for people to find easily what they wanted to know and learn. The encyclopedia was the answer, because it brought such information together in one place where it could be found readily.

The word *encyclopedia* comes from the Greek word *enkyklopaedeia*. This Greek word means *teaching in the circle* of the arts and sciences. The word *cyclopedia* is also sometimes used to convey the same meaning. The reference works of ancient scholars were not called by either name. In fact, the word *encyclopedia* did not come into common use until the 1700's.

A well-planned, standard encyclopedia should:

1. Present important facts about man; about man's beliefs, ideas, and achievements; about the world he lives in; and about the universe of which he is a part.
2. Present these facts without bias or personal opinion, in language that is easy to understand.

An encyclopedia is concerned with the *who*, *what*, *when*, *where*, *how*, and *why* of things. For example, the article on Radar tells us *what* radar is, *who* developed it, as well as *when* and *where*. It also describes *how* radar operates and *why* it is important in everyday life.

The encyclopedia serves a different purpose from that of the dictionary. The dictionary shows how to spell and pronounce a word. It gives various meanings for the word, illustrates how it is used, and tells its derivation. The well-planned encyclopedia goes beyond this. For example, the dictionary explains the word *airplane* in a brief space, but the encyclopedia devotes many pages to the subject.

The World Book article on Airplane tells how the coming of the airplane has influenced our everyday life. You learn what happens before, during, and after a flight. You learn about the different parts of a plane and how they work, as well as how an airplane is built. Other features include "Famous Airplane Firsts" and detailed information about the development of the airplane. Pictures, tables, and diagrams, many in color, make the text even more interesting and meaningful.

No one person can write and illustrate a general encyclopedia. Such an enterprise calls for the combined talents of scholars and specialists, of researchers and librarians, of editors and educators, and of artists and map makers. It also calls for a tremendous investment of money by the publisher. To keep an encyclopedia abreast of events in all fields of knowledge, the publisher must have a permanent staff of trained and experienced editors.

The well-built encyclopedia is an important educational tool for use in the school, home, and library. Such a reference work presents more information on a wider range of subject matter than the average person can acquire during four years in college.

How an Encyclopedia Is Built

Planning, writing, illustrating, and manufacturing an encyclopedia is a complex project. Before any actual work can be done, the publisher must make a number of basic decisions. What is to be the general objective of the encyclopedia? For whose use is it to be planned? What subjects should be included and what subjects should be left out? How is its content to be arranged? How many volumes and how many pages is it to have? Is it to be illustrated? What kinds of illustrations are to be used and which ones are to be printed in color? If maps are to be included, what kind shall they be? Which ones are to be printed in color, and what experienced map-making firm is to prepare them? What can be done to make it easy for the reader to locate information quickly? The publisher must answer these and many other questions if his encyclopedia is to be successful.

General Objective. Before the editors can decide on a list of subjects to be included, they must know the general purpose that the encyclopedia will serve. How the subject matter is developed will depend on whether the encyclopedia is to cover one or many areas of knowledge. For example, the objective of The World Book is "to describe, explain, and picture the present and past of man, the environment of man, and the activities of man within that environment." An encyclopedia on a specific subject, such as law or medicine, presents factual information on every important phase of that subject.

The Audience. It is important to know for whose use the encyclopedia is planned. Some encyclopedias are planned primarily for the use of children and young people. Others are designed for the use of adults, scholars, and specialists. Still others, such as The World Book, are designed to serve the reference needs of the entire family.

The function of the encyclopedia editor is to provide the reader with information, accurately and objectively, so that it can be readily understood. The editor bridges the gap between what there *is to know* and those who *want to know*. He is an interpreter or translator who presents information in such a way that the reader can easily understand it. His efforts apply to both text and illustrations. The good encyclopedia editor must use ingenuity, imagination, and judgment to satisfy his readers.

Scope of the Encyclopedia. The number of pages and the number of volumes in an encyclopedia depend on the content to be covered, who will use it, and the price for which it will be sold. Regardless of the number of volumes and the number of pages, no encyclopedia has ever contained all the information available on every subject.

Arrangement of Content is a phase of encyclopedia building to which much thought has been given. Most encyclopedias use one of two basic methods of subject arrangement. These are the *alphabetical* arrangement and the *topical* arrangement.

Most encyclopedias, whether they consist of one volume or more than one, are arranged alphabetically. They may have a single alphabetical arrangement from A through Z, such as is used in The World Book. Or they may have a second alphabetical arrangement, or index. Such a second alphabetical arrangement may be put at the end of each volume, or in a separate book.

An encyclopedia arranged on a topical basis presents its content along areas of interest. For example, one volume may be devoted to plants, another to animals, and still another to history, science, or some other subject. To help the reader find information, this kind of encyclopedia must have a separate index.

Content of Each Volume. How does the publisher decide what should be put in each volume? The next time you are in a library, look at the different encyclopedias on the shelves. Some have books that are all the same thickness. Others, such as The World Book, have volumes that vary in thickness.

Encyclopedias that use the *unit-letter arrangement* have all subjects beginning with the same letter of the alphabet in the same volume. For example, all World Book articles beginning with the letter *A* are found in the A volume. Articles that begin with the letter *B* are in the B volume. Sometimes two or more consecutive letters of the alphabet are combined in one volume.

If the volumes of an encyclopedia have the same thickness, it is not always possible to put into one volume all articles beginning with the same letter of the alphabet. The first volume may be marked *A* to *Anna*, and the second *Anna* to *Baltic*. The first volume has only part of the articles beginning with the letter *A*. The second volume has the remainder of the articles beginning with the letter *A* and some articles beginning with the letter *B*. This arrangement is called the *split-letter system*.

Illustrations are invaluable to the process of learning and informing. Important visual aids include pictures, maps, and diagrams. Their educational and informative value depends on the creative flair and ingenuity of the editors and artists working together. Never was the old Chinese proverb "A picture is worth 10,000 words" more true than it is in the case of the encyclopedia.

The use of color for illustrations has increased with the improvement of printing presses. It has helped make the encyclopedia more informative and appealing.

Maps are an indispensable feature of a good encyclopedia. With the coming of the airplane, radio, telegraph, telephone, and television, people in all parts of the world have become neighbors. Colorful maps help the reader to become better acquainted with the political, physical, and other features of these countries. The maps in The World Book were especially designed and created through the cooperation of World Book and Rand McNally editors.

Ease of Use is important to every person who wants to look up information in an encyclopedia. A single alphabetical arrangement and the unit-letter system make an encyclopedia easier for the young person to use.

Another helpful device is the use of *cross references*. As you read an article, the word *see* may refer you to another article in the encyclopedia for further information. A cross reference may also be a separate entry in bold type. It may contain little or no information, except to tell the name of the article in the encyclopedia where the information can be found. For example, John Chapman and Johnny Appleseed are the same person. The article in The World Book is on *Appleseed, Johnny*. There is a cross reference to this article from *Chapman, John*.

Still another kind of cross reference is the *Related Article*. At the end of many articles, you will find a list of Related Articles in The World Book. These articles give additional information on some subject related to the one you have just read. For example, a few of the related articles following Air are Nitrogen, Oxygen, and Wind.

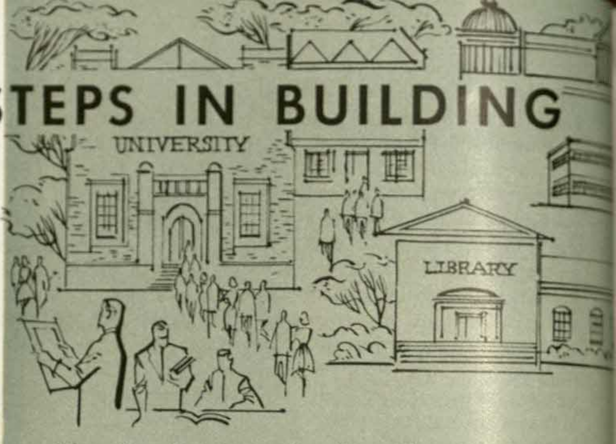
In long articles, centerheads and sideheads in heavy type help the reader find information quickly. A glance at them tells the general content and organization of the subject. At the end of such long articles, you will also find outlines and lists of books you may want to read.

How a World Book Article Is Prepared

Encyclopedia articles vary in length according to the importance of the subjects. Some articles may be only a

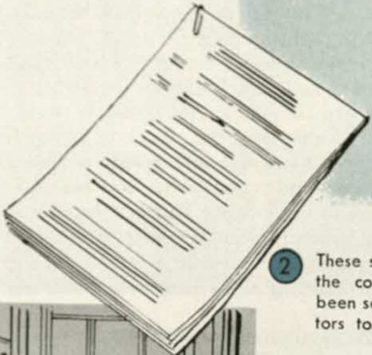
BASIC STEPS IN BUILDING

TEXT

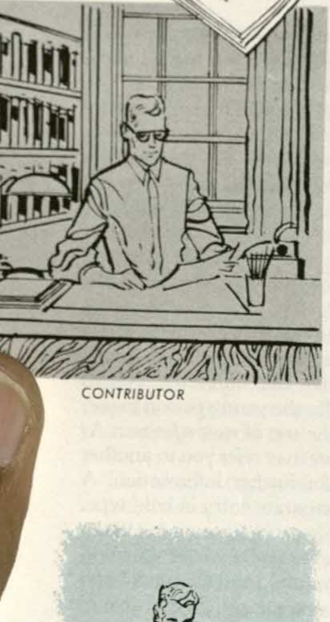


Information given in encyclopedia articles must be accurate and authoritative. This calls for thorough research by contributors, editors, reference librarians, and artists.

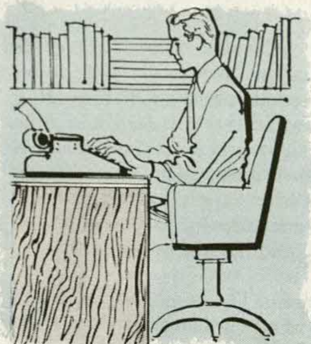
① Specifications are prepared so that the article will meet the reference needs of those for whom it is intended. The specifications, based on extensive research, indicate what content to include and how to organize it.



② These specifications guide the contributor who has been selected by the editors to write the article.

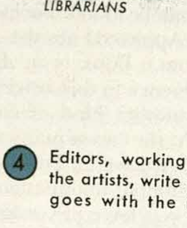


CONTRIBUTOR

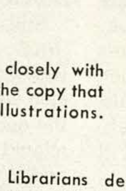


EDITOR

③ The article, after being written, is carefully edited. All facts and figures are checked by researchers and reference librarians.

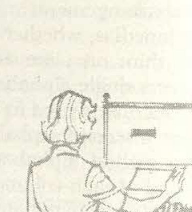


LIBRARIANS

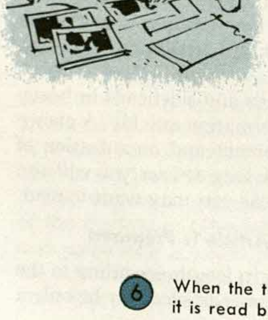


CONSULTANTS

READABILITY EDITOR

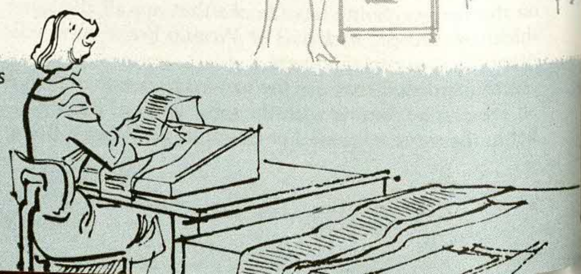


RESEARCHERS



④ Editors, working closely with the artists, write the copy that goes with the illustrations.

⑤ Librarians decide on cross references that make it easy for the reader to find what he wants to know.

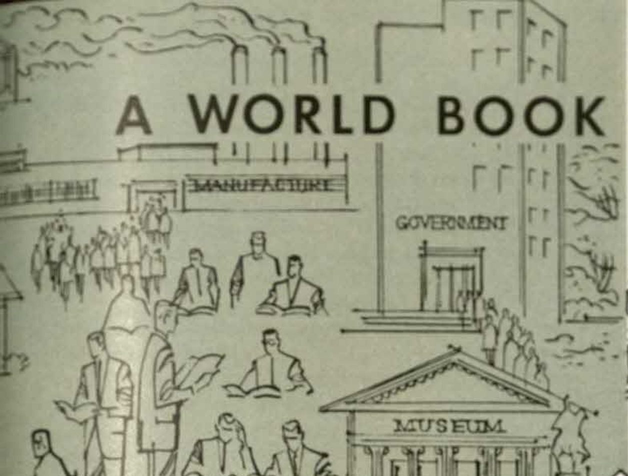


PROOFREADERS

⑥ When the text is set in type, it is read by proofreaders to make sure there are no errors.

A WORLD BOOK ARTICLE

ILLUSTRATIONS

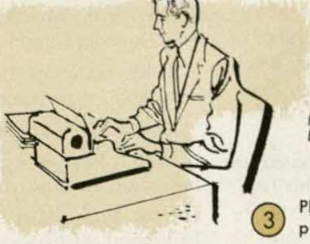


Text and illustrations together tell the story. Editors and layout artists decide what to illustrate and how best to illustrate the article.

① The layout artist makes rough sketches to determine what art work to use. He also plans where it and other illustrations are to appear in the article.

LAYOUT ARTIST

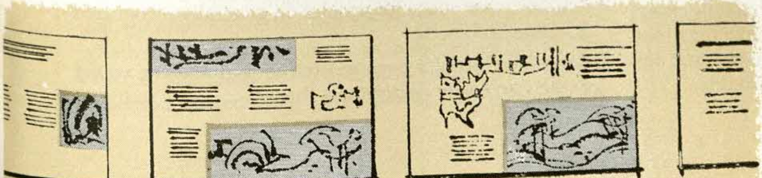
② Skilled artists then prepare the finished art work.



③ Photographs are selected that appeal, inform, and reproduce well.

④ Art work and photographs sent to the engraver are marked for size and for any colors to be used.

⑤ Proofs of the engravings are checked and corrected when necessary.



⑥ Proofs of text and illustrations are pasted in position on each page by the art editors. Printing plates are made and the article is ready to be printed.

few lines or a few paragraphs long. Others, like the article on BIRD, may cover more than 40 pages. Methods used in preparing these short and long articles differ, depending on the kind and length of the article and on the policy of the publisher.

Once an encyclopedia has been published, constant revision is necessary. From printing to printing, the editors must add new articles and revise old ones to keep the encyclopedia up to date.

All articles in THE WORLD BOOK are written or entirely rewritten according to a well defined step-by-step procedure. An editorial committee, made up of executives and editors in charge of various subject fields, decides what revisions will be made for each printing. In the case of major articles, whether they are to be newly written or completely revised, the following steps are taken.

Preparing Specifications. The editors of THE WORLD BOOK prepare *specifications* for each article, to tell the contributor what it should include and in general how it should be developed. Before the editors prepare specifications, they must study the subject thoroughly to learn what information will have the greatest value for the reader. They pay special attention to the requirements of school courses of study. THE WORLD BOOK was the first reference work to make detailed analyses of hundreds of leading school courses of study. Its continuing survey of these courses serves as an important guide to the editors in including necessary information in articles that are revised.

When finally approved, the specifications indicate the length, organization, and general purpose of the article. They also indicate the approximate number of words for each major section and the school grade levels for which the information is generally intended. Specifications also include suggestions for pictures, tables, diagrams, and maps.

Selecting a Contributor. A specialist is invited to write each article. He must be an authority in his field. The editors choose him because of his knowledge or special skills, or because he has already written articles or books on the subject. They send the specifications to him, explaining the nature of his assignment and asking him to suggest ways of improving the specifications.

Editing the Manuscript sent in by the contributor calls for expert skill. An editor reads the manuscript to get a general grasp of what has been written. He then changes it, if necessary, to conform to WORLD BOOK policies in matters of content, style, and punctuation. He checks the facts and information, clarifies any difficult concepts, and adds any further facts that may be needed. The manuscript is checked by researchers, style editors, educators, and readability specialists. After all changes have been incorporated, the edited copy of the article is returned to the contributor for his final approval.

Illustrating the Article calls for the skills of artists and layout experts. They work closely with the editor in selecting photographs and in planning pictures and diagrams. Together, the text and pictures tell the story. Eye appeal is important, so the artist and layout expert place pictures and color where they will have the greatest value. Presenting information attractively is as important as making it clear and understandable.

Writing captions for illustrations is an important phase of the editor's work. Captions must be descriptive, clear, and brief.

Making Cross References to text and illustration is the work of qualified, trained librarians who direct readers to specific facts or articles. Information that might otherwise be hidden is made easy to find. The Related Articles listed at the end of articles are also checked by these library specialists.

Setting the Type. If the encyclopedia is to be published for the first time, or if it is being completely revised, the publisher must decide: What is to be the size of the printed page? What kind of type is to be used? How large should it be? To achieve a readable page, many factors are considered, including length of line; space between lines; margins at top, sides, and bottom; and space between columns.

Decisions of this nature call for the technical assistance of type designers and other specialists. The type face used in THE WORLD BOOK is Baskerville. It was chosen by one of the world's leading type designers because it is easy to read. Space between lines and columns, margins, and the bold type for subject entries were all planned to achieve ease in reading.

Reading Proof, before and after articles have been set in type, calls for great accuracy and concentration to avoid errors. Once the final proofs have been read, printing plates are made and the task of printing and binding can begin. To learn more about the mechanical aspects of making encyclopedias and other books, see BOOKBINDING; PRINTING; PROOFREADING.

How to Judge an Encyclopedia

Among the questions the prospective purchaser of an encyclopedia should ask himself are the following:

Is the encyclopedia published by a company that is reputable, experienced, and well-established?

Does it have a permanent editorial and art staff?

Does it have an Editorial Advisory Board made up of nationally known educators and scholars?

How authoritative is it? You can determine this by looking at the list of contributors and consultants at the beginning of the first volume. By looking at the end of each major article in THE WORLD BOOK, you can find the name of its contributor.

Is there a definite editorial plan followed throughout? Check the organization of such groups of articles as states, provinces, presidents, and countries.

Are the articles accurate? Look up articles in fields with which you are familiar. Are the text and pictures understandable? Do they include all important facts?

Have the articles been written without bias and prejudice?

Does the encyclopedia cover subjects in all areas of knowledge?

Do you prefer the alphabetical arrangement or the topical one?

Has consideration been given to the length of articles, with adequate space for articles on generally recognized important subjects?

Have the articles been written so that readers, young or old, can easily understand them?

How easy is the encyclopedia to use? Check the following:

1. Does it have a single alphabetical arrangement or some other arrangement?
2. Is it organized with the unit-letter or the split-letter arrangement?
3. Are the volumes numbered and lettered clearly?
4. Is there a liberal use of cross references?
5. Are difficult words pronounced?
6. Do long articles have center and side headings in bold type?
7. Are the article titles boldly identified?

Are the articles well illustrated?

Has color been used in the pictures and maps?

Do major articles have lists of books to read?

Is the encyclopedia kept up to date through a program of continuous revision? Check such subjects as Airplane, Guided Missile, and Space Travel.

Does the publisher have an *Annual Supplement* or *Yearbook* that reviews the outstanding events of each year?

How well are the books made? Is the paper of good quality? Is the printing good? Is the binding sturdy, insectproof, and washable?

For further information on how to judge an encyclopedia, see Constance M. Winchell's *Guide to Reference Books*, published by the American Library Association.

Before you purchase an encyclopedia, make sure that you understand its basic purpose and plan. If necessary, consult a librarian to make sure that the work is standard and modern. And, after you purchase the encyclopedia, *use it!* Put it in the place, at home or in school, where it can give maximum value.

History

The First Reference Works. Scholars often call Aristotle "the father of encyclopedists," because he made one of the first attempts to bring all existing knowledge together in a series of books. But he also gave his own ideas on many subjects. Marcus Terentius Varro made the next attempt. He wrote a nine-volume work on the arts and sciences called *Disciplinae*. No actual copies of either Aristotle's or Varro's works exist today. Scholars know of them only from copies made at a later date. See Aristotle; Varro, Marcus Terentius.

Pliny the Elder wrote a set of reference books called *Historia Naturalis*, or *Natural History*. This set is the oldest reference work in existence. It contains thousands of facts, chiefly about minerals, plants, and animals. See Pliny (The Elder).

Isidore, Bishop of Seville (about 560-636), worked for 30 years on his *Etymologiarum libri XX*. Scholars used this 20-volume work for nearly 1,000 years as a source book. Today, scholars seldom depend on it, because they cannot check its accuracy. Isidore almost never mentioned the sources of his information.

Until the 1200's, encyclopedia writers arranged their material according to personal preference. In 1260, a Dominican friar named Vincent of Beauvais completed his *Speculum majus*, the first reference work that was organized by topic. Vincent divided his material into three broad fields: political history, natural history, and academic subjects. The title *Speculum majus* means *The Bigger Mirror*. Vincent wanted to reflect all human knowledge in his work. Scholars continued to refer to a reference work as a *speculum*, or mirror, long afterward.

Bartholomew de Glanville, a professor of theology in Paris during the 1200's, wrote *De proprietatibus rerum*. His book remained a standard reference work in European universities for hundreds of years. It first appeared in Latin, and was translated into English, French, and other languages. Bartholomew stressed the religious and moral aspects of each topic.

European Encyclopedias. After Johannes Gutenberg perfected the use of movable type to print books, there were a number of new developments in the late 1400's. Many persons wanted reference works in their own language, instead of Latin. About 1481, William Caxton published *Mirror of the World*, one of the first reference works in English (see Caxton, William). Raffaeli Maffei, an Italian writer who worked in Rome, published *Comentarii Urbani* in 1506. This Latin work was the first to include biographies.

Johann Heinrich Alsted, a German Protestant theologian, published one of the last reference works in Latin, *Encyclopaedia septem tomis distincta*, in 1630. Alsted was the first author to stress geography in a reference work. Louis Moreri, a French Roman Catholic priest, published *Le Grand Dictionnaire Historique* in 1674. It emphasized history, genealogy, and biographies. The first alphabetical reference work in English was the *Uni-*

RED-LETTER ENCYCLOPEDIA DATES

322 B.C. Aristotle, father of the encyclopedists, attempted to bring together in a series of books all the knowledge of his time.

30's B.C. Marcus Terentius Varro wrote a nine-volume work called *Disciplinae*, on the arts and sciences.

A.D. 77-79 Pliny the Elder wrote a reference work called *Natural History*.

1260 Vincent of Beauvais arranged information by topics in his *Speculum majus* (*The Bigger Mirror*).

1481 William Caxton's *Mirror of the World* was one of the first reference works published in English, and the first to use illustrations.

1541 Ringelberg of Basel was the first to use the word *encyclopaedia* in the title of a reference work.

1704 John Harris in his *Lexicon Technicum* was the first to arrange articles alphabetically, to include bibliographies, and to use articles by specialists.

1704 The *Reales Staats-Zeitungs und Konversations-Lexikon* in Germany was the first encyclopedia to be made up entirely of the work of many contributors.

1728 Ephraim Chambers, in his *Cyclopaedia*, was the first to make use of cross references.

1751-1780 Denis Diderot and Jean d'Alembert published their *Encyclopédie*.

1768-1771 *The Encyclopaedia Britannica* was the first to treat subjects systematically.

1893 The *Student's Cyclopaedia* was the first school encyclopedia.

1902-1904 The *New International* was the first encyclopedia to set up staffs of authorities and writers.

1918 A policy of continuous revision was established by The World Book Encyclopedia.

1936 The World Book Encyclopedia was the first reference work to conduct an extensive survey of school courses of study to determine the reference needs of young people.

1961 The World Book Encyclopedia was the first encyclopedia to be published in braille.

versal, Historical, Geographical, Chronological, and Classical Dictionary, published by an unknown author in 1703.

John Harris (1667?-1719), an English theologian and scientific writer, published his *Lexicon Technicum, or An Universal English Dictionary of Arts and Sciences*, in 1704. It was the first reference work to arrange articles alphabetically, to include bibliographies, and to use articles contributed by specialists. Also in 1704, Johann Hubner, rector of a Latin school in Germany, published *Reales Staats-Zeitungs und Konversations-Lexikon*. It was the first reference work to consist entirely of the work of many contributors. Ephraim Chambers (? -1740), a British writer and translator, published his *Cyclopaedia, or the Universal Dictionary of Arts and Sciences*, in 1728. Chambers developed the idea of using cross references to make it easier for his readers to find information.

After 1700, most encyclopedias followed the same general pattern. Scholars in many countries began to publish reference works.

In France, a translation of Ephraim Chambers' *Cyclopaedia* became popular. Denis Diderot and Jean d'Alembert used the *Cyclopaedia* as the basis for their *Encyclopédie ou Dictionnaire raisonné des Sciences, des Arts et des Métiers*. This 28-volume work appeared between 1751 and 1765. Five volumes of additional information, called a *supplement*, appeared within a few years. Diderot published a two-volume index of the *Encyclopédie* in 1780. He and his friends were called *encyclopedists* because of their work. The *Encyclopédie* contains many of their revolutionary opinions (see DIDEROT, DENIS). The 31-volume *La Grande Encyclopédie* was published in France from 1866 to 1902 by an outstanding group of scholars and men of letters. *Larousse du XXème siècle*, based on an earlier encyclopedia by Pierre Larousse, appeared in 1928.

In Germany, Johann Heinrich Zedler, a Leipzig bookseller, edited the 64-volume *Universal Lexicon*. This work appeared in several volumes a year from 1732 to 1750. It included biographies of living persons for the first time in any reference work. Friedrich Arnold Brockhaus, a German bookseller, first published his *Konversations-Lexikon* in 1796. It contained many short, simple articles, and was extremely successful in Europe. Its latest edition appeared in the 1950's under the title *Der Grosse Brockhaus*.

The *Allgemeine Encyclopädie der Wissenschaften und Künste*, edited by Johann Samuel Ersch and Johann Gottfried Gruber, was one of the largest reference works ever published. The editors began work on it in 1818, but never finished. By 1889, it included 167 volumes. The first part of the work, covering information under the letters A to G, took up 99 volumes.

Hermann Joseph Meyer, a German journalist, published the first edition of his *Neues Konversations-Lexikon* in 1839. It emphasized the study of science, and flourished for many years.

In Great Britain, the first edition of the *Encyclopædia Britannica* appeared in 100 installments between 1768 and 1771. It was published "by a Society of Gentlemen in Scotland." The second edition, published between 1778 and 1783, included biography and history. Although earlier reference works had included these topics, encyclopedias at this time did not usually have them.

Other European Encyclopedias include the 55-volume Soviet *Bolshaya Sovietskaya Entsiklopediya;* the 39-volume *Enciclopedia italiana di Scienze, lettere ed arti;* the Spanish *Enciclopedia ilustrada Europeo-Americana;* the 32-volume Swedish *Svensk Uppslagsbok;* and the 7-volume *Schweizer Lexicon* in Switzerland.

Encyclopedias in the United States and Canada are many and varied. They range from encyclopedias in special fields to those on general areas of knowledge. Some are especially planned for young people, others for adults, and still others for family use.

Works on specific areas of knowledge include the *Encyclopedia of the Social Sciences*, *The Catholic Encyclopedia*, *The Jewish Encyclopedia*, and *The New Encyclopedia of Sports*. One-volume general encyclopedias include the *Volume Library* and the *Lincoln Library of Essential Information*.

Reference works planned for the use of adults include *Collier's Encyclopedia*, *The Encyclopedia Americana*, and *The Encyclopædia Britannica*. The leading family encyclopedias are the 20-volume WORLD BOOK ENCYCLOPEDIA and *Compton's Pictured Encyclopedia*.

In Canada, the *Encyclopedia of Canada* was published in six volumes between 1935 and 1938. The 10-volume *Encyclopedia Canadiana* appeared in 1958. These works deal with subjects of special interest to Canada.

In 1961, THE WORLD BOOK ENCYCLOPEDIA was published in braille, making an encyclopedia available to blind persons (see BRAILLE [picture]).

Encyclopedia sales soared in the 1940's, 1950's, and early 1960's. This trend was not surprising, because an encyclopedia is concerned with knowledge, and, especially today, knowledge is power. J. MORRIS JONES

Related Articles in WORLD BOOK include:

Cross Reference
Index
Literature
Literature for Children
Reading
Study
Vocabulary

Outline

I. How an Encyclopedia Is Built
- A. General Objective
- B. The Audience
- C. Scope of the Encyclopedia
- D. Arrangement of Content
- E. Content of Each Volume
- F. Illustrations
- G. Maps
- H. Ease of Use

II. How a WORLD BOOK Article Is Prepared
- A. Preparing Specifications
- B. Selecting a Contributor
- C. Editing the Manuscript
- D. Illustrating the Article
- E. Making Cross References
- F. Setting the Type
- G. Reading Proof

III. How to Judge an Encyclopedia

IV. History

Questions

What does the word *encyclopedia* mean?

How does a publisher keep an encyclopedia accurate and up to date?

What is the oldest reference work in existence?

How does the purpose of an encyclopedia differ from that of a dictionary?

Why is an encyclopedia a highly important educational tool?

What are five points to look for in judging an encyclopedia?

Which was the first reference work to determine the reference needs of young people by analyzing school courses of study?

What are two basic methods of encyclopedia subject arrangement?

Who is called "the father of encyclopedists"?

What is the main function of encyclopedia editors?

END OF THE TRAIL is James E. Fraser's famous statue of a weary Indian astride his tired horse. See Fraser, James Earle.

ENDACOTT, PAUL. See Basketball (Great Basketball Players and Coaches).

ENDECOTT, or **ENDICOTT, JOHN** (1588-1665), an American colonial leader, led about 50 people from England to what is now Salem, Mass., in 1628. He governed the colony until John Winthrop arrived in 1630. Endecott remained a leader in Salem, while Winthrop established Boston (see Winthrop [John]).

Culver

John Endecott

Endecott served as governor of Massachusetts Bay Colony for several terms. His zeal often led him astray. He was largely responsible for causing the Pequot War (see Indian Wars [The Pequot War]). He slashed the red cross out of the British flag because he thought it was a symbol of the pope. He persecuted the Quakers. But he used the colony's ministers to bring harmony to the community. He was born in Devonshire, England. Bradford Smith

ENDEMIC DISEASE. See Disease (Kinds).

ENDERBY LAND is a region on the fringe of Antarctica. It extends from Ice Bay to Edward VIII Bay. Enderby Land was discovered in 1831 by British navigator John Biscoe, who worked for a whaling company called Enderby's. For location, see Antarctica (color map).

ENDERS, JOHN FRANKLIN (1897-), a research bacteriologist, shared the 1954 Nobel prize for physiology and medicine with Frederick C. Robbins and Thomas H. Weller. The three grew poliomyelitis viruses on living human embryonic tissue and neutralized the virus' cell-changing action with an antibody. They later isolated and typed the three strains of polio virus (see Poliomyelitis). Enders' work showed that viruses can be grown outside the body in tissues that they do not usually attack within the body. This work provided a method for producing vaccines to combat the viruses. Enders helped develop typhus vaccine and isolated the measles virus. Enders was born in West Hartford, Conn. Henry H. Fertig

ENDIVE, *EN dive*, or *AHN deev*, is a leafy vegetable closely related to chicory. It grows wild in the East Indies, but is cultivated in other parts of the world. Endive is a low-growing plant. One variety, called *escarole*, has broad, smooth leaves. The other variety has curled or fringed leaves. Both plants have a slightly bitter, but pleasant, flavor and are often used in salads. Endive does not grow well in hot weather. Methods of cultivation resemble those used for lettuce. Endive contains vitamins A, B, and C.

Scientific Classification. Endive belongs to the composite family, *Compositae*. It is classified as genus *Cichorium*, species *endivia*. S. H. Wittwer

See also Chicory; Plant (color picture, Vegetables Unknown to Our Forefathers); Vegetable (Planting Table for Vegetables).

ENDLESS CAVERNS. See Virginia (Caverns and Springs).

ENDLESS CHAIN. See Block and Tackle.

ENDOCARDITIS. See Heart (Bacterial Endocarditis).

ENDOCRINE GLAND. See Gland.

ENDOCRINOLOGY is the study of the ductless glands. See Gland.

ENDODERM. See Embryo.

ENDOGAMY. See Marriage (Marriage Customs).

ENDOLYMPH. See Ear (The Inner Ear).

ENDOR, WITCH OF. See Witch of Endor.

ENDORSEMENT. See Check; Negotiable Paper.

ENDOSPERM. See Corn (Ears); Seed (Parts).

ENDOWMENT is a fund that is set aside by a donor, or giver, for a specific purpose. The term *endowment* also has the same meaning as foundation, fund, or trust (see Foundations; Trust). The money for endowments may come from individuals, family estates, or business organizations. Most endowments are designed to run forever, or until the money in the fund has been spent. Many endowments are nonprofit, tax-exempt organizations that use their funds to perform social projects.

Endowments also refer to funds that are held by colleges, universities, hospitals, orphanages, and other similar institutions. The money of such endowments is usually invested so that the institution has a continual income of some kind. Usually, the institution spends only the income or profit from the investments. In this way, the endowment can continue forever. Generally, the income is used only for the general operations of the institution, or for some particular purpose for which the endowment was created. Joseph C. Kiger

See also Insurance (Life Insurance).

ENDYMION, *en DIM ih un*, was a beautiful young shepherd who lived on Mount Latmos in Greece. According to Greek legend, Selene, the moon-goddess, fell in love with him as he slept, and ignored her duties. Zeus, king of the gods, gave Endymion a choice between death and eternal sleep. Endymion chose sleep. The Greeks believed that Selene was visiting Endymion whenever the moon hid behind a cloud. John Keats wrote a long poem called *Endymion*. H. Lloyd Stow

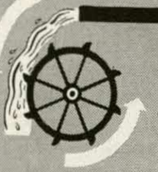
Curly Endive has a bitter but pleasant flavor. The inner leaves are used in salads, and the outer ones are cooked.

J. Horace McFarland

ENERGY is the name given to the ability to do work. Work and energy are measured in the same units. People often confuse energy, power, and force. Force is something that moves an object or body. The amount of work is determined by the strength of the force used and the distance through which it moves. Power measures the rate at which work is done.

All human life depends upon the energy in the universe. Most of the energy on earth comes from the sun. It travels from the sun to the earth in the rays that the sun gives off. The sun's rays are needed so that plants can make food. The food that plants make is the food on which all the animals in the world depend in order to live. Animals and man use the energy found in food to operate their bodies and muscles. The sun's energy is stored up in coal, wood, and oil, which man burns to do work for him. The sun evaporates the water, which falls to the earth as rain. This causes rivers to flow and produces other energy that man can use. The amount of energy falling on the earth's surface each year is equal to that supplied by 250 million million tons of coal, or about 100,000 tons of coal for each person on earth.

FORMS OF ENERGY

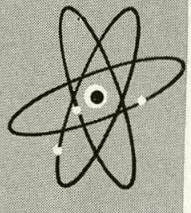


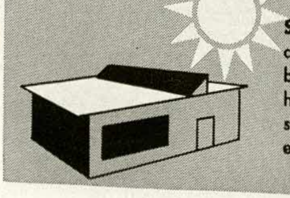
Mechanical Energy is found in machines. The water wheel, *left*, changes the kinetic energy of falling water into mechanical energy.

Chemical Energy is released when matter changes chemically. When wood burns, it combines with oxygen and gives off heat.

Electrical Energy can be turned into many other forms of energy, including light, heat, and sound.

Atomic Energy is released when atoms split or combine. It can be turned into electricity and other forms of energy.





Solar Energy is the radiant energy given off by the sun. It provides heat and light, and is the source of much of the energy found on earth.

The history of human development is the history of man's discovery of new sources of energy he could use to do his work for him. Primitive man had only the strength of his arms and the use of fire. He made crude tools that he used by hand. He later discovered that it was possible to use the energy of the wind to move his sailing vessels. He used the energy of water to turn his mills. He tamed animals as new sources of energy. They pulled plows and wagons. A new stage in the development of the use of energy came with the invention of the steam engine. Steam could be used to develop the energy used to run machines. The discovery of electricity created an even more important way of using energy. So did the invention of the gasoline engine. Man has now entered into a new era of the use of energy, with the application of atomic energy.

Energy is one of the two fundamental ideas in physics. The other is matter. These two ideas are not completely separate. Many physicists believe that energy and matter are merely two aspects of the same thing, much as ice, water, and water vapor are three different aspects of water. The tiny electric particles (electrons) inside the atom give off the energy we know as light. A body loses part of its mass when it releases energy. It gains mass when it absorbs energy.

Sources of Energy

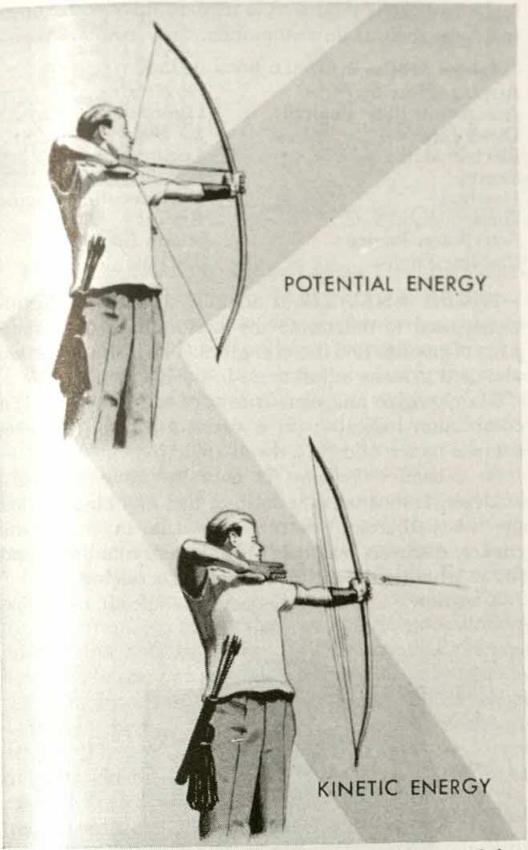
Energy of various kinds is often made available by chemical changes. Heat and light are given off when some substances combine with oxygen in burning. Energy can also be produced from physical changes. For example, heat is absorbed when a gas expands inside pipes. This principle is widely used in refrigeration. Man finds many ways of releasing energy to do work. He changes the energy in a waterfall into electrical energy that can be carried on a wire for hundreds of miles. He can turn this electrical current into radio waves that can carry his ideas for thousands of miles. He can also make a chemical reaction provide electricity to help run his automobile. He can release the energy in gasoline by burning it, and make it send airplanes through the sky. He can use coal to turn water into steam, and in turn use the steam to run his locomotives and to generate electrical energy as well. He can use a beam of light to control electrical energy through the photoelectric cell. Some energy comes from heat, other energy from light. Sound is a form of energy. Mechanical energy is developed when man uses a stream to run a watermill or electric generator. These examples show that energy can be transformed from one form into another.

One of the most important sources of energy exists in the nucleus of the atom. The nucleus of certain atoms can produce millions of times more energy per pound of material than can be made available by chemical means. See Atomic Energy.

Other possible sources of energy have been considered. Machines have been developed to use the direct effects of sunlight to create energy for heating. Methods have been proposed for harnessing tides.

Potential and Kinetic Energy

Potential Energy is often called *energy of position*. It represents work that has already been done. A rock lying on the top of a cliff has potential energy. A loco-



Bent Bow in the upper picture contains potential energy. *Below,* the release of the bow has changed its potential energy into the kinetic energy which propels the flying arrow.

motive under a full head of steam waiting for the touch of the throttle has potential energy, and so does the cartridge in a loaded rifle. When the rock is toppled over the cliff, when the locomotive begins to move, when the gun is fired, the potential energy is changed to *kinetic* energy.

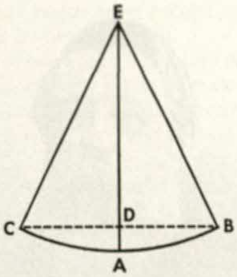
Kinetic Energy is the energy of movement. The rock on the edge of the cliff had to be placed in that position. The gun had to be loaded and the locomotive had to be heated with burning fuel. If you stretch an elastic band between your fingers, it represents potential energy. Let the band snap back into its normal position, and the potential energy is changed to kinetic energy as long as the band keeps moving. The word *kinetic* comes from a Greek word meaning *to move*. A moving train, a running horse, a thrown baseball, or a high-speed electron in a TV tube all exhibit kinetic energy.

Changes in Energy. Energy is constantly changing from the potential to the kinetic state and back again. Every change that takes place in the universe represents the change of energy from one form into another. This process is called the *transformation of energy*. For example, let us analyze what happens when a boy shoots a stone from a slingshot. When the boy pulls back the rubber band, the potential energy in the boy is changed to the potential energy in the stretched band. When the boy releases the band, the potential energy is changed to kinetic energy of the thrown stone. When the stone strikes a target, the kinetic energy becomes heat energy. This energy could be detected with sensitive instruments.

The Conservation of Energy

The law of conservation of energy states that the amount of energy in the universe is always the same. It can neither be increased or lessened. You can get only as much energy out of a machine as you put into it. Usually, you cannot even get this amount of energy out of any machine in a usable form. Much of the useful energy is wasted by friction in the form of heat. Friction will cause any machine to run down eventually.

The pendulum is one example of the way energy changes and is conserved. When we move the bob of the pendulum from *a* to *b*, we are doing work upon it. When it reaches *b*, it contains stored-up potential energy. When the bob is released, it swings to *c*. Its energy will be wholly kinetic at *a* and wholly potential at *c*. The pendulum would swing back and forth forever if it were not for friction and the resistance of the air. But the energy used up in overcoming such friction is not lost. It is merely changed to heat (see PENDULUM).



Because energy and matter are now known to be closely related, the law of the conservation of energy has been interpreted in a new light. Energy cannot be created or destroyed. But it may be developed from matter and turned into matter.

Measuring Energy

Work is measured in *foot-pounds*, or the amount of energy it takes to lift one pound through a vertical height of 1 foot. Energy is measured in the same way. If you raise a 50-pound weight to the top of a table that is 4 feet tall, the weight will have 200 foot pounds of potential energy. If it were pushed off the edge of the table, the weight could do 200 foot-pounds of work. See FOOT-POUND.

Potential energy is always measured by multiplying the weight of any object by the height of its position. The measuring units of the metric system are sometimes used in calculating energy. Then the unit is the *gram-centimeter*, the amount of work done to raise a weight of 1 gram through a vertical height of 1 centimeter.

Kinetic energy is measured by this formula: kinetic energy equals half the mass of an object times the square of its velocity.

ROBERT F. PATON and RALPH E. LAPP

Related Articles. See the PHYSICS section in the READING AND STUDY GUIDE. See also the following articles:

Atomic Energy
Chemistry
Chlorophyll
Efficiency
Electric Generator
Electricity
Force
Heat
Joule
Light
Matter
Motion (Momentum)
Perpetual Motion
Power
Quantum Theory
Radiation
Radiometer
Relativity
Solar Energy
Sound
Turbine
Water Wheel
Work

ENESCO, GEORGE. See Romania (The Arts).

ENFIELD RIFLE. See Rifle.

ENFORCEMENT OF LAW. See Law Enforcement.

ENGADINE, *EN guh deen,* is the name of the narrow valley of the Inn River in eastern Switzerland. It contains many picturesque villages and castles. Many health and resort centers are located there because of the valley's mineral springs, mild climate, and the nearby mountains. The most famous resort is Saint Moritz. Many of the valley's people speak Romansh (see Romansh Language). [illegible]

ENGAGED COLUMN. See Architecture (Architectural Terms).

ENGELS, FRIEDRICH (1820-1895), with Karl Marx, wrote the *Communist Manifesto* (1848), the basic document of present-day socialism and communism. He and Marx were the most important German theorists and organizers of the Marxist movement, both in Europe and America (see Marx, Karl). Engels also wrote *The Condition of the Working Classes in England in 1844, Notes of the War 1870-1871,* and *The German Peasant War,* translated into English in 1926. The Marx-Engels Institute in Moscow has published the collected works of the two men since 1926. Engels was born in Barmen, Germany. [illegible]

Brown Bros.

Friedrich Engels

See also Communism (Marxian Socialism).

ENGEL'S LAW states that as a family's income rises, a smaller share is spent for food and a larger share for education and recreation. This "law" is really only a rough general statement, with many exceptions. The German statistician, Ernst Engel (1821-1896), originated the law.

ENGEN, ALF. See Skiing (History).

ENGINE, *EN jin,* is any mechanism which can change energy into mechanical work. The steam engine, for example, uses the expanding energy of steam to drive a piston. The drive of the piston does work, such as turning the wheels of a locomotive. The steam engine and the gas, oil, and hot-air engines are called *heat engines,* because they all change heat energy into mechanical work. In gasoline and oil engines the fuel burns inside the engine cylinder, and therefore these engines are also often called *internal-combustion* engines. The fuel burns, or explodes, in a confined area. This produces high pressures in the gases which are products of the combustion. The gases usually act directly upon a piston, making it turn a shaft.

Another type of engine, the *hydraulic engine,* uses water pressure to produce mechanical work. The pressure may be produced by a pump, or by water at a level above the engine, so that the water's tendency to flow downhill produces pressure.

Engines of all types are used to transform energy from fuels, from steam, or from air or water under pressure, into mechanical energy involving motion. The mechanical energy thus produced is used to drive some other machine, such as an automobile. [illegible]

Related Articles in World Book include:

Airplane (Engines)
Automobile (The Engine)
Diesel Engine
Electric Motor
Energy
Flywheel
Force
Free-Piston Engine
Gasoline Engine

Governor
Hydraulic Engine
Jet Propulsion
Locomotive
Piston
Reciprocating Engine
Rocket
Steam Engine
Turbine

ENGINE ANALYZER is actually a group of instruments used to determine the performance of various parts of gasoline and diesel engines. The instruments are also used to make adjustments in the engines.

Many engine analyzers consist of four devices: (1) a combustion indicator; (2) a vacuum gauge; (3) a resistance meter; and (4) a dwell-angle indicator.

A *combustion indicator* is actually an exhaust-gas analyzer. It measures the ratio of fuel and air supplied by the carburetor, detects disorders in automatic chokes, discovers leakage in the intake manifold, and shows whether the air cleaner needs servicing.

A *vacuum gauge* indicates several defects, including ignition timing errors and improper valve action.

Sun Electric Corp.

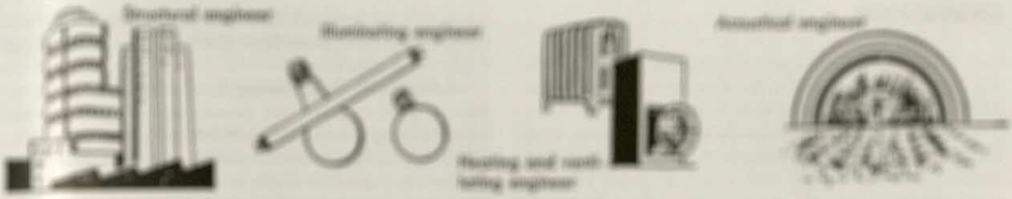
An Engine Analyzer tests the performance of various gasoline and diesel engine parts, and detects any defects in them. Repairs can be made easily once the defects have been discovered.

A *resistance meter* determines the condition of the ignition coil and the ignition condenser.

A *dwell-angle indicator* tells how the breaker points in a distributor are adjusted. [illegible]

See also Diesel Engine; Gasoline Engine.

ENGINE TURNING is a form of ornamentation most often used on coins, watch cases, and other metal items. It is made by a lathe attachment that turns in an eccentric movement. The marking consists of a crosshatching of curved lines in a form similar to a rosette. In ceramics, engine turning is used to cut geometric, fluted, or diced designs in dried, unfired pottery. In *rose engine turning,* a complicated design is produced by making the article vibrate as it rotates around a stationary cutting tool. [illegible]



THE WORK OF ENGINEERS IN BUILDING CONSTRUCTION

ENGINEERING is the art and science of using power and materials most effectively in ways which are valuable to man. Originally the term engineer was applied to a person who produced military weapons or defenses. Today it usually refers to a person who has been graduated from an engineering college. An engineer designs and builds such structures as dams, highways, railroads, factories, and skyscrapers. He helps produce such machines as airplanes, automobiles, diesel engines, electrical generators, and the like. He plans and constructs plants such as oil refineries, powerhouses, copper smelters, and factories which produce chemicals.

Outstanding engineering feats include the Pyramids of Egypt, the Panama Canal, Boulder (Hoover) Dam, the San Francisco Bay bridges, giant telescopes, streamlined trains, and airplanes that carry hundreds of passengers. No one can view these accomplishments without being impressed by the skill, time, and effort which were spent by engineers. Engineers made the necessary designs. They selected the right materials to use. They carefully checked all calculations of strength to make sure the structure would stand up under the most extreme conditions under which it might be used. Finally, engineers planned and supervised the work of hundreds of men who actually put all these greatly differing structures together.

The engineer knows what he wants to make, whether it is a flint hatchet or an eight-cylinder automobile. Often he knows how to go about producing it. If no one has ever done this before, he knows how to find out how to produce it. In ancient times these things had to be learned by trying over and over again until a successful way was finally found. Nowadays a person can go to high school and college and learn what thousands of engineers have done in the past. Through education, the modern engineer need not repeat their failures, but can build on their accumulated experience and accomplish even more than they did.

Kinds of Engineering

The term *engineering* includes many different kinds of activity. The most important different kinds of engineering are now recognized as distinct professions. Exact dividing lines between the duties of different kinds of engineers are hard to find. For example, while chemical engineers design plants where chemicals are manufactured, and know how to lay out tanks and piping systems, they must also understand the uses of condensers, filters, electric motors, and various kinds of pumping equipment. It is, however, possible to separate roughly the various types of engineering according to the principal kinds of work involved in each.

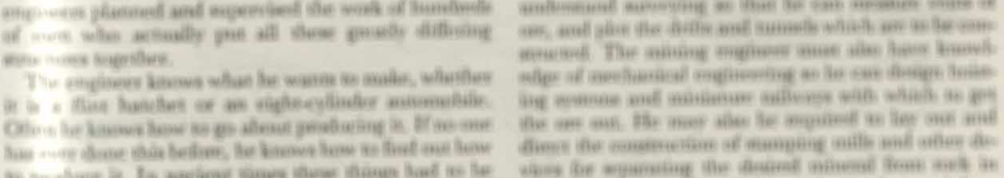
Most early engineering was of two kinds. Machines of a very simple type were used in warfare. These were designed by military engineers. Roads and buildings were designed and their construction was supervised by nonmilitary, or civil, engineers.

Civil Engineering deals with the building of canals, tunnels, roads, bridges, dams, airfields and railways. Civil engineers must be experts in surveying, and must understand the uses of concrete, iron, and steel, as well as the handling of earth by power shovels and bulldozers.

Mining Engineering involves finding the cheapest and most effective ways of getting coal, oil, ores, and other minerals out of the earth. The mining engineer must be something of a civil engineer. He must also understand surveying so that he can measure veins of ore, and plan the drifts and tunnels which are to be constructed. The mining engineer must also have knowledge of mechanical engineering so he can design hoisting systems and miniature railways with which to get the ore out. He may also be required to lay out and direct the construction of stamping mills and other devices for separating the desired mineral from rock in which it is found. The mining engineer who specializes in petroleum engineering must know how to bore deep wells and set up pipe lines and pumps to bring oil to the surface of the earth.

Structural Engineering involves the design of skyscrapers and other large buildings, and of factories and docks and similar structures. In these structures it is especially important that girders, concrete pillars, walls, and other mechanical parts be strong enough to withstand any strains to which they may be subjected. Small houses are designed by architects, who may also be responsible for the layout and appearance of larger build-

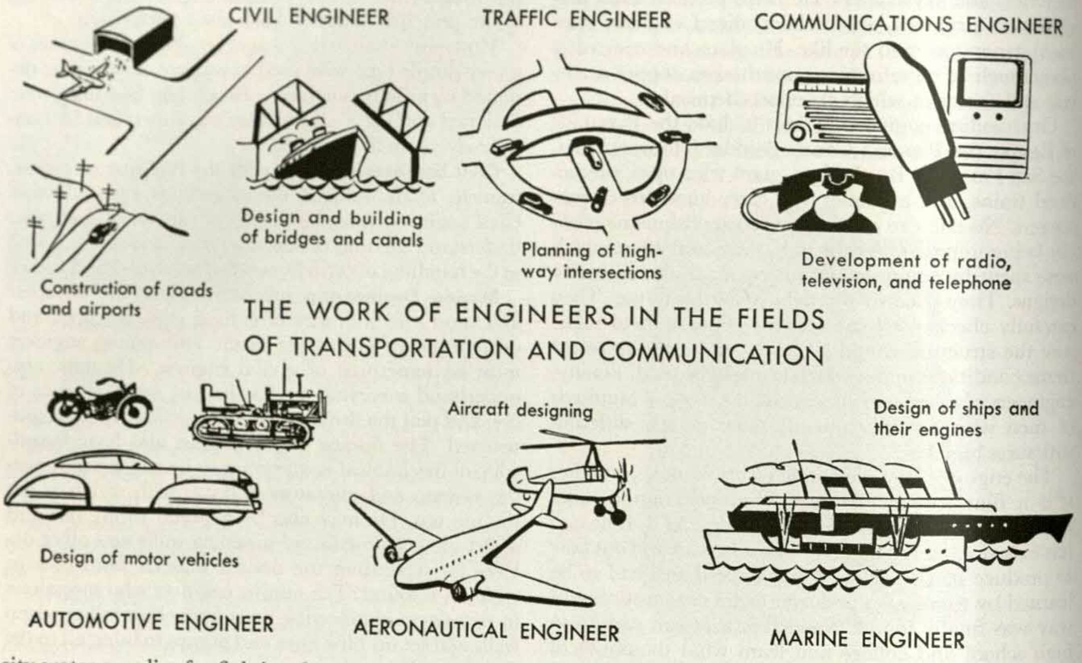
THE WORK OF ENGINEERS IN INDUSTRY



ings. But a structural engineer is usually responsible for the detailed planning of large structures, and for supervising the construction of such buildings.

Traffic Engineering has to do with the laying out of highways and traffic intersections in such a way that automobiles may travel from place to place with the least danger or delay. Highways are usually constructed under the direction of civil engineers. A traffic engineer is called in to plan such things as cloverleaf intersections, overpasses, underpasses, and other devices for speeding up traffic safely.

Hydraulic Engineering involves the design of systems through which water flows. A hydraulic engineer in this field can calculate how much water will flow through a pipe of a certain size under a certain pressure. He designs aqueducts, drinking water supply systems, and city water supplies for fighting fire.


CIVIL ENGINEER
TRAFFIC ENGINEER
COMMUNICATIONS ENGINEER
Construction of roads and airports
Design and building of bridges and canals
Planning of highway intersections
Development of radio, television, and telephone
Aircraft designing
Design of ships and their engines
Design of motor vehicles
AUTOMOTIVE ENGINEER
AERONAUTICAL ENGINEER
MARINE ENGINEER

THE WORK OF ENGINEERS IN THE FIELDS OF TRANSPORTATION AND COMMUNICATION

Sanitary Engineering is concerned with the design of sewage-disposal systems for towns and cities, and with sources of pure drinking water. The sanitary engineer may design plants for the treatment of water with chlorine or other chemicals to kill germs, and plants to convert sewage into fertilizer. Great cities like present-day New York City and London are possible largely because of the work of sanitary engineers. They have brought fresh, pure water through large pipe lines into these cities, and have arranged sewers to carry away foul wastes so they cannot serve as breeding places for germs. Sewage and drainage systems have greatly reduced many diseases which once killed large numbers of people. Because of the work of sanitary engineers, men can now live and work in some tropical regions where formerly yellow fever, typhoid fever, cholera, or malaria made this impossible. The sanitary engineer works closely with the hydraulic engineer. Together they have drained vast areas of swamps such as the Everglades in Florida, and have built dams which store water to irrigate deserts and make them into prosperous farms, as in the Imperial Valley of California.

Hydroelectric Engineering is concerned with the design of power plants for generating electrical power from running water. Hydroelectric engineers must design dams to store water in ponds, and channels called *penstocks* to carry the water to waterwheels or turbines. They install generators of electric power which are turned by water turbines. They also arrange systems for distributing this power to distant points where it is needed. Boulder (Hoover) Dam is one of the greatest triumphs of the hydroelectric engineer (see HOOVER DAM). Power from the stored water of the Colorado River is used to generate electric power which is sent to cities as far as 300 miles away. More and more, man turns to water as the source of electric power.

Electrical Engineering deals with the design of electrical machinery, of power plants for producing electric power from steam, water, or other power, and of wire networks for distributing this power efficiently to customers. The electrical engineer designs new and improved types of motors and generators. He selects the proper type of motor for driving air blowers or water pumps or lathes. He may design an electrical system for changing a section of a great railroad from operation by steam locomotives to operation by electric locomotives. He is prepared to decide where power stations should be located, or what voltage of electric power should be distributed. He knows how to set up overhead trolley wires to distribute power to locomotives, and how to protect electric systems against lightning or other damage.

Communications Engineering is that branch of electrical engineering which deals with the telephone, the telegraph, the radiotelegraph or radiotelephone, television, or any other electrical method of communicating. Students in this field are concerned mainly with electricity, but usually with smaller currents than are involved in electric power engineering. They are especially concerned with the uses of vacuum tubes and other electronic devices. Communications engineering is one of the principal applications of electronics. See ELECTRONICS.

Illuminating Engineering involves the design of lighting systems. An architect who is designing a factory building may call in an illuminating engineer to decide how many incandescent or fluorescent lamps should be used in each room. The illuminating engineer also decides how they should be arranged and mounted, and how much electric power should be provided in order to give the proper amount of light on work tables in the room.

Mechanical Engineering deals with the design of machinery, such as steam, diesel, and gasoline engines, power shovels, milling machines, and lathes. The mechanical engineer studies the strengths of various materials such as steel and bronze. He knows how to design gears with teeth strong enough to carry any specified load, and how to apply power from engines to do useful work. This important field is now being subdivided into various branches, including the automotive and aeronautical branches.

Industrial Engineering deals with the scientific management of industry. The industrial engineer usually has a broad knowledge of chemical and mechanical engineering, because these studies are widely applied throughout industry. But the industrial engineer chiefly concerns himself with the methods and tools of mass production. He must be able to determine the most efficient and economical ways of handling and processing materials. He must also know what tools and machinery can best perform a particular task. An important phase of his job is called *time and motion study*, which analyzes the time required to perform an operation. Industrial engineers use these studies to save costly steps in a manufacturing process. For every step he saves in a complex industrial operation, the industrial engineer saves thousands of dollars and many man-hours for his company. Time and motion studies also make it possible to introduce entirely new ways of doing routine jobs.

Aeronautical Engineering is the field of the aircraft designer. This is one of the newest and most rapidly growing fields of engineering. The airplane is a product of the present century, and plane speeds are rapidly rising from the original 40 miles an hour to 700 miles an hour or more. The sizes of planes are constantly increasing as engineers are able to design stronger wings, more powerful engines, and landing gear which will hold up the great weight of such planes. Dirigibles and other balloons are also designed and constructed by certain specialized aeronautical engineers. Many special instruments and devices must also be designed for airplanes.

Automotive Engineering is the field of designing automobiles, tractors, motorcycles, and similar machines. Products of the skill of the automotive engineer include streamlining, the development of more power with an engine of given weight, and greater comfort and ease of handling of motor cars. The engineer is constantly trying to design engines which will develop more power from a given amount of gasoline than those now available. Automatic gearshifts, hydromatic transmissions, hydraulic brakes, and improved carburetors which have led to less expensive operation are all advances made by the automotive engineer.

Heating and Ventilation Engineering deals with the design of systems for keeping the air in buildings pure and at the proper temperature and humidity. An engineer specializing in this field knows how to design efficient fans to blow air through ducts. He can calculate the amount of air which will flow from this fan through a duct of a given size and length. He knows how to remove moisture from air with water sprays or refrigerating machines, and how to control air temperature with thermostats.

Acoustical Engineering involves the design of such buildings as concert halls, bandstands, opera houses, and auditoriums in which sound effects are important. The acoustical engineer co-operates with the architect in making sure that the reflection of sound from the walls of a room will not be so great as to interfere with clear hearing, nor yet so little that the room sounds "dead," or as though the listener were in the midst of a great empty space. He specifies the type of ceiling and wall coverings which are to be used, so that just the right amount of sound will be reflected. He also deals with the quieting of machinery, and with the lining of the walls of airplanes and trains so that the engine and other noises will be shut out.

Chemical Engineering includes the design of plants where such chemicals as acids, fertilizers, plastics, glass, fuels, and certain food products are manufactured. The chemical engineer designs the machinery and processes to carry on the manufacture of such materials. Engineers of this kind must be able to lay out pipe lines, conveyer belts, furnace systems, vats, and similar devices for conveying, storing, and preparing chemical substances. The great plants in which gasoline and kerosene are produced from crude petroleum were designed by chemical engineers.

Agricultural Engineering deals with preparation of soil, planting of seeds by machinery, cultivating and irrigating, and harvesting of growing crops. Such machines as tractor-driven plows and harrows and cultivators, power sprayers, potato diggers, and cotton pickers are invented, adapted, and improved by the agricultural engineer to increase the crop yield from a given acreage of land. The agricultural engineer lowers the cost of producing crops, and contributes greatly to the improved efficiency of the farm. Thus he reduces the drudgery and increases the profits of the farmer.

Marine Engineering and Architecture is the design of ships, and of the engines which drive them across the ocean. A good marine engineer knows how to shape the sides of a vessel so that it will slip through the water as easily as possible, and yet be able to carry a large cargo. He must be sure that he makes the hull of the ship strong enough that it will not break in two when the bow and the stern are held up by waves, while the hull between receives no support. He must also calculate and arrange to furnish the amount of power needed to drive the ship at the desired speed.

Military Engineering, the original kind of engineering, now involves little except the application of various kinds of engineering to military purposes. Great 16-inch guns require the best efforts of the metallurgical engineer to produce steel strong enough for their barrels.

Mechanical engineers are needed to design the proper taper and rifling and to construct machines which will handle and form such gigantic pieces of mechanism. Chemical engineers develop improved explosives which will propel the shell as far as possible. Military engineering has now become so involved as to require the best efforts of all scientists and engineers during wartime. See ENGINEERS, CORPS OF.

Importance of Engineering

Human beings cannot be really happy if they have to spend all their waking hours from youth to old age working hard under uncomfortable conditions. In primitive times people had to work very hard to be sure to have enough to eat. Modern engineering has taught us how to use the power in falling water and steam and electricity to do much of the work which previously had to be done by human hands. Today each resident of the United States uses, on the average, so much power from coal mines and electric power plants and other sources of power that it would require the constant drudgery of thirty men if this power had to be supplied by human labor.

As engineering develops further, the amount of manual labor that human beings will need to do will gradually decrease. Only a few years ago a laborer was expected to work twelve hours a day. This is still true in some countries where engineering methods are not yet used. In the United States, six to eight hours is considered a full day's work.

As increased leisure is made available by engineering, man can get more rest and recreation, can improve his surroundings and living conditions, and can raise his general health level. His working conditions can be made more pleasant, and he will find greater enjoyment in his work when it depends on use of both mind and muscle, rather than muscle alone. He can use more time for study, training, and education, so that he can raise his intellectual level, and thus lead a happier and more useful life. He can be paid more by his employer, or earn more from his own business, when he directs the labor of a dozen electric motors rather than of a hundred laborers.

In these ways, engineering increases the comfort, safety, security, health, happiness, and general welfare of mankind, by making use of scientific discoveries to direct more effectively the flow of energy and disposition of materials.

PROFESSIONAL ENGINEERING SOCIETIES

Society	Address
American Institute of Chemical Engineers	25 West 45th St. New York 36, N.Y.
American Institute of Electrical Engineers	33 W. 39th St. New York 18, N.Y.
American Institute of Mining, Metallurgical and Petroleum Engineers	29 W. 39th St. New York 18, N.Y.
American Society of Civil Engineers	33 West 39th St. New York 18, N.Y.
American Society for Engineering Education	University of Illinois Urbana, Ill.
American Society of Mechanical Engineers	29 W. 39th St. New York 18, N.Y.
Engineering Institute of Canada	2050 Mansfield St. Montreal, Quebec
National Council of State Boards of Engineering Examiners	Palmetto State Life Bldg. P.O. Drawer 1404 Columbia, S.C.

History of Engineering

Earliest Times. Primitive man led a very dangerous life. Whether he got enough to eat depended largely on chance. His food supply came from roving wild herds, passing birds, wild roots, fruits, berries, and the uncertain yield of grain from the wild grasses which happened to grow in his neighborhood. Water, which after air is the substance most necessary to support life, flowed in the valleys, and to the banks of streams he went to live. His home usually consisted of what shelter he could find in the top of an especially rugged tree or in a natural cave. He learned only slowly to improve this by the use of his hands. His stay in any one spot depended on the weather and the presence of food.

Man gradually learned how to improve his condition. Over the centuries he found that fire gave warmth, and that he could control this fire and heat his cave with it. He learned how to plant, and water crops. He tamed animals and harnessed them to pull. Eventually he learned to use wheels to make a sort of cart. He built rafts, and then boats. Eventually he learned how to put a sail on his boat so the wind would move it for him. Gradually, very gradually, he learned to save some food from times of plenty to use in times of famine. He also learned to dam the rivers that spent all their waters in time of flood, so that he could irrigate his crops during times of drought. Thus he learned how to smooth out the ups and downs of existence, and his life became more comfortable. He slowly reduced the effect of chance on human living.

The individuals who first learned how to do these things deliberately were really the first engineers. The man who found that he could throw a stone at an animal harder and farther with a sling than with his arm alone was an early engineer, as were also the men who later designed the first hatchet, spear, or bow and arrow.

Engineering in Ancient Civilizations. There must have been some very able engineers among the ancient Egyptians. The Sphinx and the Pyramids could have been built only by someone who carefully worked out ways of pulling heavy stones over great distances. The Great Wall of China was built by the hard labor of vast numbers of coolies, but it required real engineering skill in design so that it would not crack and fall apart. The Hanging Gardens of Babylon show the existence of clever engineers over two thousand years ago. Ancient India, Burma, and Siam all show evidences of civil engineering skill of a high order. The stones of Angkor Wat, a large palace in Cambodia, are in very large blocks which have been fitted together with such accuracy that they form the building without the use of any cement to keep them in place.

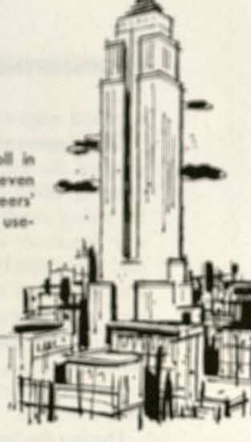
The Greeks and Romans also must have had good engineers, for many of their roads are still in use. The original stone paving is still intact after many centuries. Many of the aqueducts which they built to carry streams of water great distances around hills and across valleys are still standing. During the Middle Ages great castles were built along the Rhine and other rivers in Europe. These and the cathedrals of medieval European cities

Metropolitan Water District of Southern Calif.

The Great Colorado Aqueduct, longest man-made water supply line in the U.S., carries the waters of the Colorado River 250 miles across mountains and desert to 67 California communities.

SEVEN ENGINEERING MARVELS OF THE U. S.

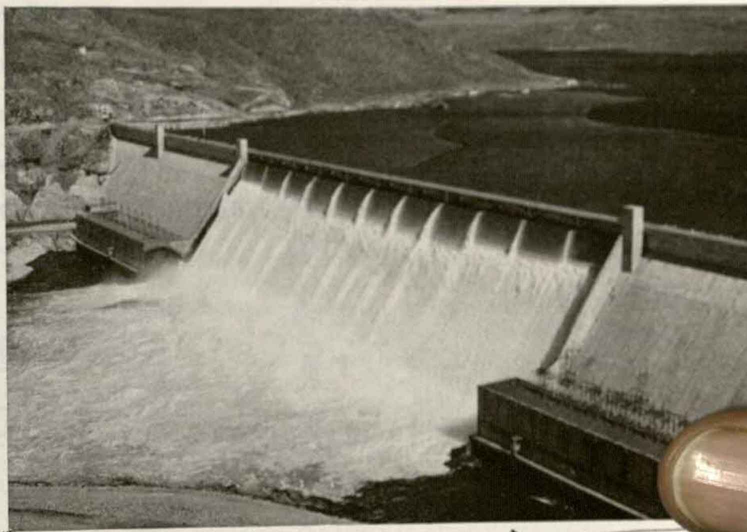
The American Society of Civil Engineers took a poll in 1955 to find out what its members considered the seven engineering wonders of the United States. The engineers' standards for picking these seven projects included usefulness, beauty and size, and newness of ideas.

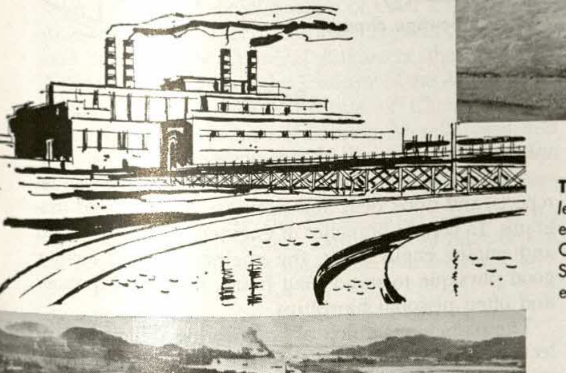


The Empire State Building in New York City towers 102 stories, and is the world's tallest skyscraper.

Grand Coulee Dam on the Columbia River in Washington, *below*, is the world's largest concrete dam and source of water power.

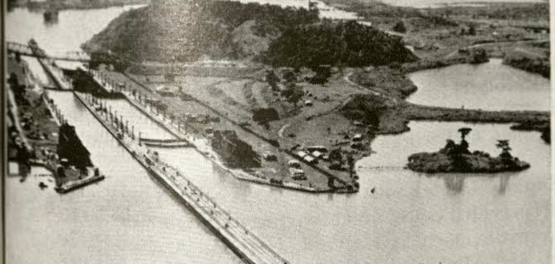
Bureau of Reclamation





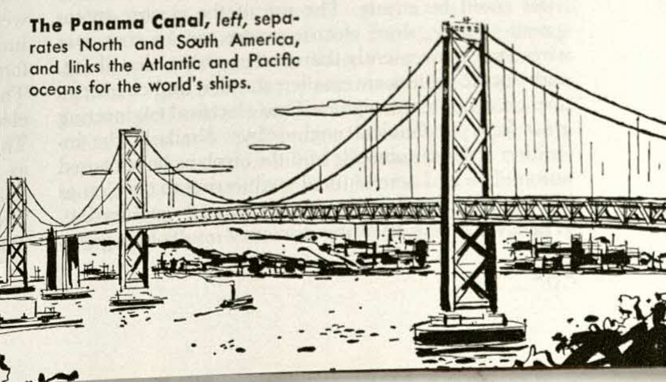
The Chicago Sewage System, *left,* was put into operation after engineers reversed the flow of the Chicago River. The city's West-Southwest Plant is the world's largest sewage-disposal plant.

Hoover Dam, on the Nevada-Arizona border, is the highest in the United States, 726 feet. It furnishes hydroelectric power for a vast area in the Southwest.



United Press Int.

The Panama Canal, *left,* separates North and South America, and links the Atlantic and Pacific oceans for the world's ships.



San Francisco-Oakland Bay Bridge boasts two suspension spans, each 2,310 feet long. Its anchorage pier is driven 140 feet into the ground beneath San Francisco Bay.

required engineering skill of high order to build.

Development of Modern Engineering. By the beginning of the eighteenth century, though man had become civilized and had succeeded greatly in improving his living conditions, he still lived without much definite assurance of what the next day would bring. He had developed social organizations, so his property was protected to some extent, but he was still made very uncomfortable at times by exposure, thirst, hunger and disease. Since most land transportation was by horse or camel, or by walking, one part of the world knew very little about another part, except in regions near seacoasts.

During the late 1700's, mechanical engineering began to develop rapidly. Simple steam engines had been used for many years, but they were clumsy, weak, and inefficient, and were used mainly to pump water from mines. Only after 1769 did the engine become really practical. In that year James Watt invented an improved form of steam engine which could do a great deal more work than any previously available, while burning the same amount of coal. Then factories began to hum, for it became possible to install a steam engine and operate a factory anywhere coal could be taken, instead of relying on human muscles, or horse-drawn, windmill-driven, or water-powered machines.

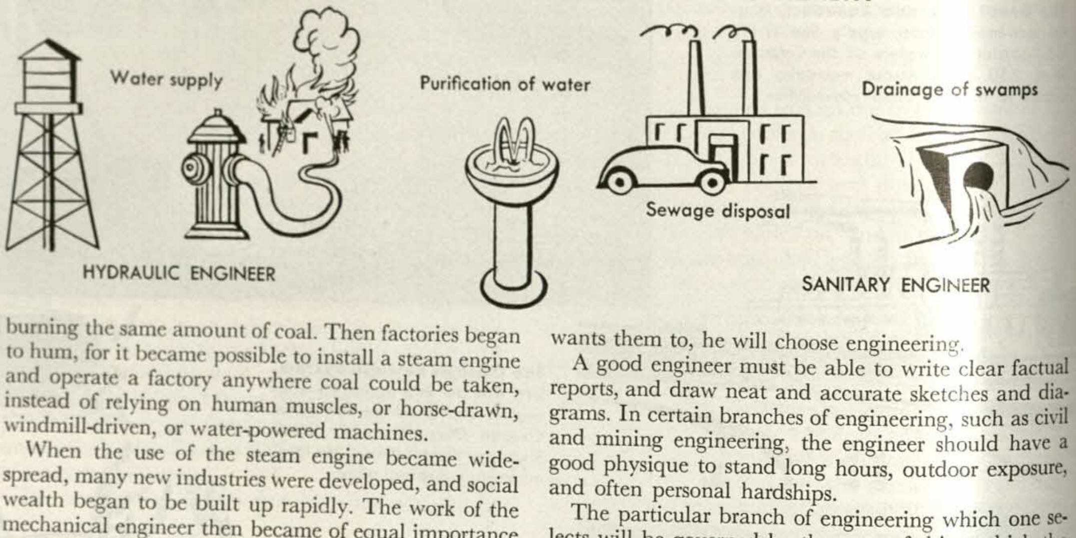
When the use of the steam engine became widespread, many new industries were developed, and social wealth began to be built up rapidly. The work of the mechanical engineer then became of equal importance to that of the civil engineer.

Electrical engineering was not important until nearly 1900. It received its first real impulse in 1831 when Michael Faraday discovered that an electric current could be generated in a wire merely by moving it across a magnetic field, without the use of any battery of any kind. This made the invention of the dynamo possible, so power could be delivered anywhere that wires could be strung. The use of the electric motor spread rapidly, since electric power can be sent over wires more conveniently than coal can be carried about, and electric motors are smaller, simpler, and cleaner to operate than steam engines. Thus electrical engineering grew from mechanical engineering. Similarly the invention of the automobile and the airplane have caused automotive and aeronautical engineering to develop as highly specialized parts of mechanical engineering. Whenever a new scientific discovery results in a group of inventions which are important in getting things done for mankind in a new, simpler, cheaper, or more effective way, a new branch of engineering is likely soon to be born.

Careers in Engineering

Boys with an engineering bent are likely to show it at an early age. The boy who gets pleasure out of designing things to make, or making things according to plans which he finds in books or magazines, will find engineering a good life work to consider. Whether he can become an engineer rather than a technician, or skilled worker with his hands, will depend upon his ability in such scientific subjects as mathematics, physics, and chemistry, and on whether he can do creditable work at college. Most engineers are trained in universities or advanced technical schools. At some time in his career, perhaps not until he has completed a year or two in college, he will be able to decide whether he is more interested in a scientific or an engineering career. He will choose science if he is especially interested in finding out how the forces of nature operate. If he is especially interested in making things work the way he wants them to, he will choose engineering.

ENGINEERING CONTRIBUTIONS TO MAN'S HEALTH



A good engineer must be able to write clear factual reports, and draw neat and accurate sketches and diagrams. In certain branches of engineering, such as civil and mining engineering, the engineer should have a good physique to stand long hours, outdoor exposure, and often personal hardships.

The particular branch of engineering which one selects will be governed by the type of thing which the student likes to do most. If he enjoys field work he may spend most of his time in the open, supervising the construction of dams, bridges, mines, refineries, and other projects which he has designed. If he prefers the office, there will be plenty to keep him busy directing draftsmen and working out designs with the formulas he finds in his engineering handbooks.

Engineering Schools. The United States is especially well provided with good engineering schools. Most universities, such as Harvard, Cornell, Purdue, Stanford, and Michigan, have strong engineering schools. These schools contain departments of civil, mechanical, electrical, chemical, and other types of engineering. There are a number of institutions of college level, such as the Massachusetts Institute of Technology, Rensselaer Polytechnic Institute, and Georgia Institute of Technology, which specialize primarily in engineering. They may have a dozen departments, each specializing in a particular engineering field. In addition, these institutes have various scientific departments, and a few other departments which give the engineering and scientific student a desirable knowledge of cultural subjects. Highly specialized military and naval training, including engineering, is given at the United States Military Academy and at the United States Naval and Coast Guard Academies. Other countries have government schools corresponding to these.

Most colleges and engineering schools graduate students in engineering with a degree of Bachelor of Science at the end of a four-year course. Some in highly specialized fields require five years of college training for an engineer, granting the two degrees, Bachelor of Science and Master of Science or Master of Engineering, at the end of five years. Only a small number of engineers spend more than four years in college.

Engineers may go into business for themselves. It is more customary, however, for a young engineering graduate to enter the employ of an industry in his field, or an established engineering firm at a definite salary. There he will work in a group of engineers, draftsmen, and other employees who are working on some particular project. Most aeronautical engineers go to work for a company producing airplanes, while many electrical engineers are employed by the large electric companies. There are other openings with large industries.

The engineering profession is far from overcrowded, especially in the newer fields such as aeronautical, automotive, chemical, electronics, and communications engineering. Various professional societies have been organized by engineers in the United States. Among these are the American Society of Civil Engineers, the American Institute of Electrical Engineers, the American Society of Mechanical Engineers, the Society of Automotive Engineers, the Institute of the Aeronautical Sciences, the American Institute of Chemical Engineers, American Institute of Mining, Metallurgical, and Petroleum Engineers, and the Society for the Promotion of Engineering Education. GEORGE R. HARRISON

Related Articles. See the ENGINEERING section in the READING AND STUDY GUIDE and the list of Engineers in the BIOGRAPHY section of the GUIDE. See also the following articles:

Air Conditioning
Airplane
Aqueduct
Automobile
Bridge
Building Trade
Canal
Chemistry
Communication
Dam
Electricity
Engineers, Corps of
Industry
Irrigation
Lighthouse
Mining
Physics
Pyramids
Railroad
Reservoir
Roads and Highways
Ship and Shipping
Skyscraper
Street
Surveying
Telescope
Transportation
Tunnel
Water Supply

Outline

I. Kinds of Engineering
- A. Civil Engineering
- B. Mining Engineering
- C. Structural Engineering
- D. Traffic Engineering
- E. Hydraulic Engineering
- F. Sanitary Engineering
- G. Hydroelectric Engineering
- H. Electrical Engineering
- I. Communications Engineering
- J. Illuminating Engineering
- K. Mechanical Engineering
- L. Industrial Engineering
- M. Aeronautical Engineering
- N. Automotive Engineering
- O. Heating and Ventilation Engineering
- P. Acoustical Engineering
- Q. Chemical Engineering
- R. Agricultural Engineering
- S. Marine Engineering and Architecture
- T. Military Engineering

II. Importance of Engineering

III. History of Engineering

IV. Careers in Engineering

Questions

How has engineering improved agriculture?

What works of ancient civilizations show great engineering skill?

What were the two original kinds of engineers?

When did electrical engineering develop?

Who were some of the first engineers?

What kind of education does an engineer need?

ENGINEERS, INTERNATIONAL UNION OF OPERATING, is an international union affiliated with the American Federation of Labor-Congress of Industrial Organizations (AFL-CIO). The union has jurisdiction over stationary engineers and hoisting and portable engineers. Many of its members are in the construction industry. The union was founded in the United States in 1896. Headquarters are at 1125 17th St. N.W., Washington 6, D.C. For membership, see LABOR (table, Important United States Labor Unions). JACK BARBASH

ENGINEERS, CORPS OF, is the branch of the United States Army that is responsible for military engineering and for many civil engineering projects.

In peacetime, the Corps of Engineers plans and directs the construction of navigation and flood-control works for the federal government. This includes harbor dredging, dams, levees, and the like. In the early days their activities were broader. They built such public buildings as the Washington Monument.

In wartime, fighting troops depend upon the Corps of Engineers for the building of military bridges, roads, airfields, military camps, and other installations. Army engineers draw, reproduce, and distribute maps throughout the army. Units known as *combat engineers* work closely with front line troops. Their duties include demolishing roads and bridges; handling assault boats, rafts, and bridging during river-crossing operations. Army engineers place and clean mines and booby traps, and operate heavy engineering equipment under enemy fire. Engineering units are also prepared to fight as infantry troops if they are needed.

The corps as it is known today dates from 1802, when Congress authorized the President to organize the Corps of Engineers at West Point to "constitute a Military Academy." Army engineers helped build such famous civil engineering works as the Chesapeake and Ohio Canal and the Panama Canal. The corps supervised the $2,000,000,000 "Manhattan District" project that developed the first atomic bomb in 1945. Its other World War II duties included building railroads, harbors, and pipelines. MARK M. BOATNER III

Gendreau

A Grenadier Guardsman stands stiffly outside Buckingham Palace. His uniform includes a tall cap called a *bearskin.*

ENGLAND

ENGLAND is a small country in size, but for hundreds of years it has been one of the most important countries in the world. England covers a smaller area than the state of Alabama. But its people built the first great industrial civilization, and founded one of the world's largest empires. England is a kingdom joined with Wales, Scotland, and Northern Ireland to form THE UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND. London is the largest city in England and is the capital of the United Kingdom.

England lies in the southern and eastern part of the island of Great Britain. It covers three fifths of the area of the island. The seas that wash England's shores have helped to protect it from invaders. No invader has crossed the English Channel and conquered the country since 1066. Napoleon, the mighty conqueror of nearly all Europe, had to stop short at the Channel.

Low, rolling, fertile plains cover most of England. But rugged mountains rise in the northern and western parts of the country. The white chalk cliffs of Dover gave the country its ancient name, *Albion.* England's countryside is famous for its neat hedgerows, green pastures, thatched cottages, and picturesque village churches. Great industrial cities have grown up near the large coal and iron-ore mines.

The English people developed a strong love of freedom early in their history. Their democratic ideals and practices have been adopted by many other countries. The English enjoy the customs and traditions that go with their form of government. For example, they take great pride in the pomp and splendor that are a part of the coronation of their monarch.

Fearless English sailors, traders, explorers, and colonists carried their language, laws, government, and customs around the world. England became the mother country of the English-speaking world. Englishmen helped found great nations such as the United States, Canada, Australia, the Union of South Africa, and many others. English inventors made possible the Industrial Revolution, which raised standards of living in many parts of the world. England has produced great dramatists, such as William Shakespeare, and

Ewing Galloway

Buckingham Palace is the royal family's home in London. Crowds gather to catch a glimpse of members of the royal family when the Royal Standard flies from the flagpole, showing that the Queen is at home. A monument to Queen Victoria, *left*, stands in front of the palace.

such great scientists as Sir Alexander Fleming, discoverer of penicillin.

The Land

Extent: Area, 50,327 square miles. *Greatest distance:* (north-south) about 360 miles; (east-west), about 270 miles. *Coast line*, about 2,000 miles.

Physical Features: *Chief mountain range*, Pennine Chain. *Chief peak and highest elevation*, Scafell Pike, 3,210 feet; *lowest elevation*, the Fens, near Ely, below sea level. *Chief rivers*, Thames, Severn, Trent, Avon, Mersey. *Chief islands*, Isle of Wight, Scilly Islands.

Location, Size, and Surface Features. The English Channel and the North Sea separate England from continental Europe. The Irish Sea cuts England off from Ireland. The River Tweed, the Cheviot Hills, and a bay called the Solway Firth separate it from Scotland. The *Map* shows that the mountainous country of Wales lies to the west. England covers 50,327 square miles. See also GREAT BRITAIN (color map).

In general, England slopes from west to east, with the highest mountains and plateaus in the western part, and the lowlands in the east. The main mountain system is the Pennine Chain, which extends southward from the border of Scotland through central England. It is sometimes called "the backbone of England."

The Lake District, in the northwestern part of the country, is noted for its picturesque scenery. Here the Cambrian Mountains rise to Scafell Pike, the highest peak in England. Farther south, a region called the Midlands includes rolling hills and fertile valleys.

The east coast of England, along the North Sea, is low and flat. In the region near a large bay called The Wash, some of the coast is swampy. The land in the southeast is rolling, with layers of limestone and chalk under the soil. The chalk forms the famous white cliffs of Dover. Rugged southwestern England extends in a narrow rocky peninsula called Cornwall to Land's End, the westernmost tip of England. It also extends to Lizard Point, which is the southernmost point of the British Isles.

Rivers and Lakes. England's rivers flow from the central highlands to the seas. The rivers that flow east to the North Sea include the Thames, the Tweed, the Tyne, and a group of streams that join to form the Humber. The rivers flowing into the Irish Sea and the Bristol Channel on the west include the Mersey, the Dee, the Severn, and the Avon. Shorter streams flow southward into the English Channel. The Thames and the Severn are the longest rivers in England.

England's biggest lakes are in the Lake District. Here 16 lakes lie within a circle about 30 miles wide. Lake Windermere, a little more than 10 miles long, is the largest in the Lake District.

Islands. The Isle of Wight, near the southern coast, is the most important offshore island. Straits called The Solent and Spithead separate this small island from the main island. The sheltered port of Southampton, north of the Isle of Wight, is one of England's busiest ports. The small Scilly Islands group lies off the western tip of Cornwall. The Isle of Man (in the Irish Sea between Ireland and northern England) and the Channel Islands (in the English Channel) are not part of England, but they are governed by the British Crown.

Life of the People

Population: 41,673,000. *Density*, about 865 persons to the square mile. *Distribution*, urban, 80 per cent; rural, 20 per cent.

Chief Products: *Agriculture*, barley, cattle, fruits, hops, oats, pigs, poultry, rye, sheep, vegetables, wheat. *Fishing Industry*, cod, haddock, herring, mackerel. *Manufacturing and Processing*, automobiles, chemicals, leather goods, pottery and porcelain ware, ships, silverware, trucks, woolen and cotton cloth and yarn. *Mining*, coal, copper, iron, lead, tin, zinc.

The People are a blend of many groups that have lived in England for thousands of years. These groups included such invaders as the Celts, Romans, Angles, Saxons, Jutes, Vikings, Danes, and Norman French. People from Flanders (now part of Belgium), French Huguenots, Jews, and gypsies also became part of the English mixture. Each new group added its traditions and speech to the country's culture. For the story of how the English language grew, see ENGLISH LANGUAGE.

England is a little smaller than Alabama, but about

England's Green and Pleasant Land

The Landscape of England varies greatly from one part of England to another. Some counties, such as Sussex, are made up of beautiful rolling farm land. Other counties, such as Cornwall, have rock-strewn shore lines.

day late in May or early in June is set aside as the official birthday of the monarch, to take advantage of spring weather for parades and public ceremonies. See CHRISTMAS (In Great Britain; History); EASTER (In Great Britain).

Cities. Eighteen English cities have more than 200,000 persons living in them. Thirty more have more than 100,000 persons. The cluster of industrial cities in southern Lancashire, including Manchester and Liverpool, is England's most heavily populated area. Other important groups of cities include the area around Leeds and Sheffield, in western Yorkshire, and the *black country* of the Midlands, surrounding Birmingham. It is blackened by factory smoke and industrial waste. See the separate articles on English cities listed in the *Related Articles* section of this article.

Social and Cultural Achievements

Education. The Ministry of Education is a department of the government, and has general supervision over all schools in England. The Ministry sets up basic requirements for education. All children between the ages of 5 and 15 must attend school. They may go to either of two types of schools. Some schools are provided by localities, with financial help from the government. Other schools are supported by private organizations.

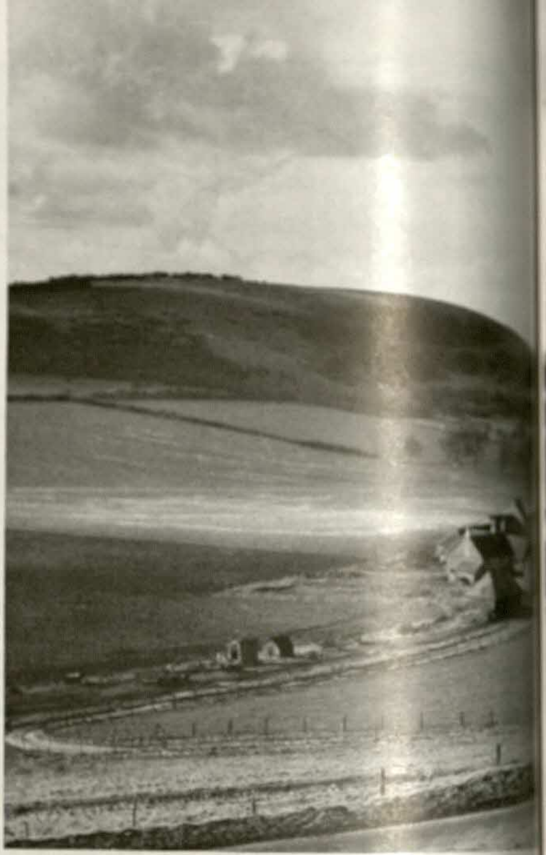
Elementary and secondary schools financed by localities are often called *county* schools. They provide free textbooks and supervise student health.

England has many kinds of private schools. Some of the best known are the large private secondary schools such as Eton, Harrow, Rugby, and Winchester. These schools are called *public*, because they are controlled by groups of trustees, instead of private individuals. By long tradition, wealthy families and the nobility send their children to these schools.

Other secondary schools operated by private groups are called *grammar* schools. Originally, they were small groups of students that met in a teacher's home. Many have grown as large as the public schools, but they are still called grammar schools. Private elementary schools that prepare boys for the public schools are called *preparatory*, or *prep*, schools. Many other private elementary schools are run by religious groups.

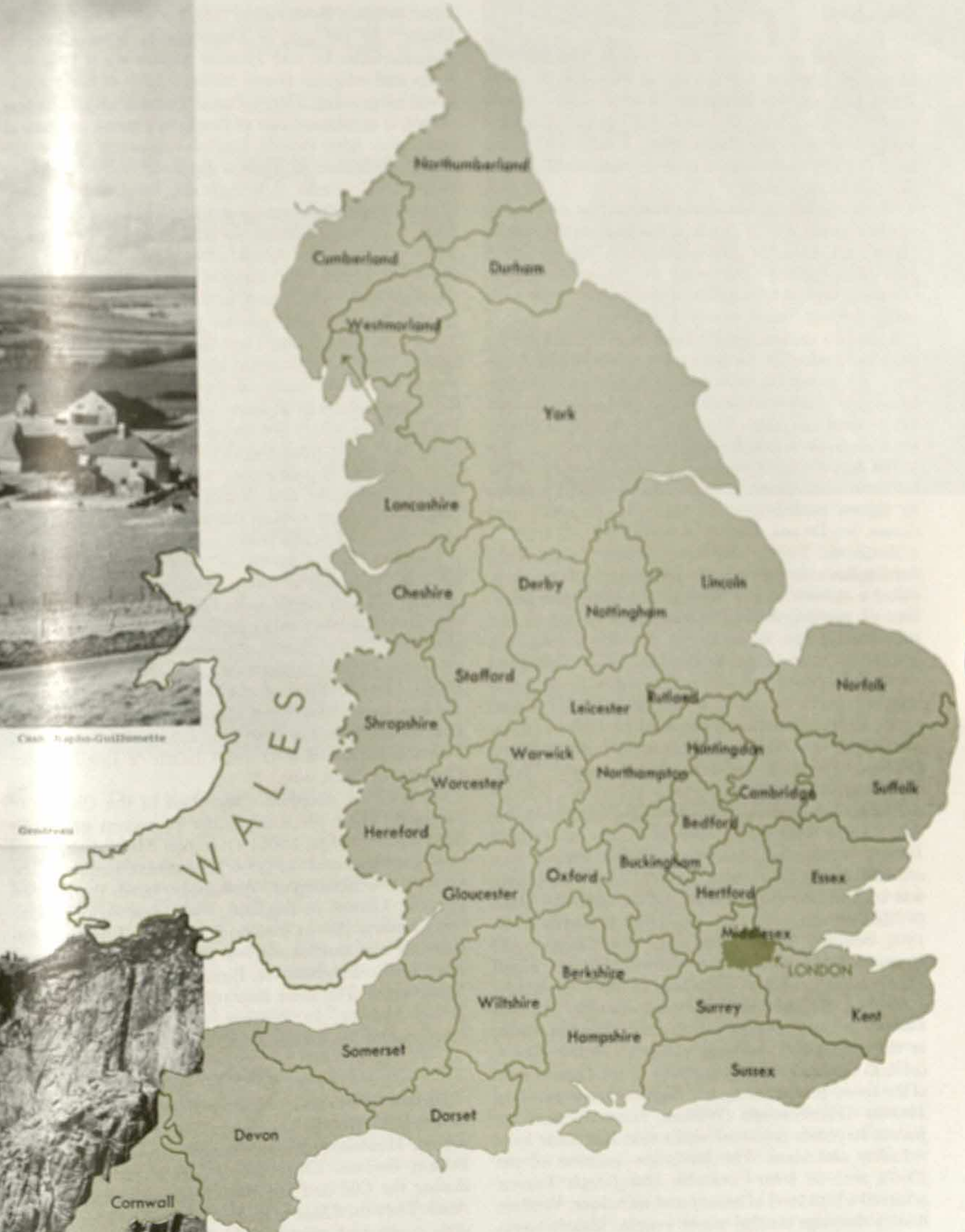
Oxford and Cambridge universities, founded in the 1100's and 1200's, represent the highest traditions of education in England. The largest university in England is the University of London. It was established in 1836, and has about 23,000 students. Other universities are located in Birmingham, Bristol, Durham, Leeds, Liverpool, Manchester, Nottingham, Reading, Sheffield, and Southampton. There are university colleges in Exeter, Hull, Leicester, and Keele.

Libraries and Museums. Monks of various religious groups founded the first libraries in England. Many rare manuscripts were lost when Henry VIII's armies



The South Downs in Sussex

Land's End in Cornwall



The 39 Historic Counties of England. The English word for county, *shire*, is added to most county names. Seven counties (Cambridgeshire, Hampshire, Lincolnshire, Northamptonshire, Suffolk, Sussex, and Yorkshire) are divided into administrative counties. London is an administrative county, but not one of the historic counties.

destroyed the monasteries in the 1530's. The first city library in England was set up at Norwich in 1608. There were other subscription libraries, where people paid to borrow books. But the public-library system did not develop until the 1800's. Many English cities now have free library systems. There are also many county libraries for rural areas.

Many English libraries have outstanding collections of old and rare books. Some of the famous collections include those in the British Museum, the Bodleian Library at Oxford University, the library of Corpus Christi College at Cambridge, and the Cambridge University Library. See BODLEIAN LIBRARY.

England's most important museum is the British Museum in London. It has finer collections in many fields than any other museum in the world (see BRITISH MUSEUM). Other famous museums in London include the Victoria and Albert Museum, the National Gallery, the Tate Gallery, and the Wallace Collection.

The Arts. England has a rich heritage in many of the fine arts. Most people consider that England reached its highest achievements in the fields of poetry and drama. See DRAMA; ENGLISH LITERATURE.

Architecture. England has many beautiful cathedrals. An English cathedral usually stands in an open area, called a *cathedral close*, with trees and lawns around it. One of the largest English cathedrals stands in the little town of Ely. It was begun in 1083, but was not finished for more than 100 years. Salisbury Cathedral was begun in 1220 and was completed in 40 years. Its 404-foot spire is the tallest in England. Many persons rank Lincoln Cathedral as the most beautiful in England. Other attractive cathedrals stand in Canterbury, Durham, Hereford, Lichfield, Peterborough, Wells, Winchester, Worcester, and York.

England also has many imposing palaces, including Buckingham Palace and beautiful old St. James's Palace. Ambassadors from other countries are still sent officially to "the Court of St. James's." Blenheim Palace was built at Woodstock for John Churchill, the Duke of Marlborough, who won the Battle of Blenheim in 1704. Beautiful manor houses and country houses add charm to many parts of the country. Cottages, small village inns, and parish churches dot the countryside.

Painting. For hundreds of years, English painters followed the styles of continental artists. Hans Holbein, in the 1500's, and Anthony Vandyke, in the 1600's, came to England to paint portraits of the famous men of the times. But, in the 1700's, English painters such as Thomas Gainsborough, William Hogarth, and Sir Joshua Reynolds produced works that had great individuality and vigor. The landscape painters of the 1800's, such as John Constable and Joseph Turner, achieved a high level of beauty and technique. William Blake's drawings startled many people. Blake's works were not appreciated during his lifetime, but they are now greatly admired. Among contemporary painters, Duncan Grant, Paul Nash, Ben Nicholson, and William Piper have received world-wide recognition.

Music. English folk songs are sung and loved in all parts of the English-speaking world. England produced a remarkable group of composers in the 1500's and 1600's. Thomas Tallis was the first and after him came William Byrd, called "the Father of Elizabethan Music." In the age of Elizabeth I, Giles Farnaby, Orlando Gibbons, and Thomas Morley wrote beautiful songs and religious choral music. Much of their music is still sung today. Henry Purcell, who lived in the late 1600's, is considered one of England's greatest classical composers. After Purcell, English composers copied the music of continental Europe for more than 200 years. In the 1870's, Sir W. S. Gilbert and Sir Arthur Sullivan began writing brilliant operettas that are popular in many countries. Leading English composers of recent times include Sir Arnold Bax, Benjamin Britten, Frederick Delius, Sir Edward Elgar, Gustav Holst, Ralph Vaughan Williams, and Sir William Walton.

Other Arts. English furniture makers were the best in Europe in the 1700's. Their home furnishings in the Queen Anne and Georgian styles were beautifully designed and built. Some of the finest furniture of this time was created by Robert Adam, who also designed the houses in which the furniture was used. Furniture collectors today prize the works of Thomas Chippendale, George Hepplewhite, and Thomas Sheraton. Josiah Wedgwood and Josiah Spode produced their famous chinaware during the same period. See FURNITURE; PORCELAIN; POTTERY.

Religion. The Church of England, or Anglican Church, is the official state church, established by Parliament. The monarch must belong to the Church of England. But every other person in the country is free to worship in the church of his choice. The monarch is *defender of the faith*, and serves as the secular head of the church. The Archbishop of Canterbury is *primate of all England*, or spiritual head of the church. In belief and ritual, the Protestant Episcopal Church of the United States is patterned after the Church of England (see CHURCH OF ENGLAND).

Most of the people are members of the Church of England. There are many other Protestant groups in England, including about 1,150,000 Methodists, 335,000 Baptists, and 225,000 Congregationalists. The Cardinal Archbishop of Westminster heads the Roman Catholic Church in England, which has about 2,800,000 members. About 400,000 Jews live in England, and there are also smaller religious groups. Islamic mosques have been established in Birmingham, London, and Manchester. The most important mosque is the Shah Jehan Mosque, in Woking, southwest of London. London also has a large Buddhist temple.

History

Earliest Britain was a country of forests, marshes, and barren land. No one knows when man first lived in the region. Historians call the people who lived in early Britain *Iberians*. These short, dark-haired men lived during the Old and the New Stone Ages (see STONE AGE). They used flint to make tools and weapons. They grew crops and raised cattle, sheep, pigs, and dogs. The Iberians gradually learned to use bronze. Historians do not know who taught them to work with metals. Another puzzle is what use they made of great stone clusters such as Stonehenge.

The First Invaders of England were the Celts. Historians now think that the tall, fair-haired Celts crossed from Continental Europe in two great waves, starting about 600 B.C. The first Celtic peoples were the *Gaels*

Sheffield Silver has been famous for quality and fine workmanship for hundreds of years. Workers still add many finishing touches by hand.

Staffordshire Pottery, with its gay colors, has been a well-known English product since the 1700's.

Sawders, Cushing; Ewing Galloway

or *Goidels*. The second wave included the *Cymri* and the *Britons* or *Brythons* (see Celt). The Celtic invasions continued for hundreds of years. The Gaels easily pushed the Iberians into the wild northern and western parts of the island. The Britons occupied most of the area that is now England and Wales.

The Celts were a hardy, warlike people. They lived in tribes and worshiped nature gods through priests called *druids* (see Druid). They used iron and mined tin. They made woolen cloth and dyed it in bright colors. The Celts traded across the Channel with the Gauls, and across the Irish Sea with Ireland. Celtic warriors painted their bodies with *woad*, a blue dye.

The Roman Conquest. Julius Caesar conquered the Gauls (in what is now France) in 55 B.C. and sailed across the English Channel with a small force to learn about Britain. The next year, he crossed the Channel with an army. According to his account, he subdued the Celtic chieftains and returned home.

About 100 years later, in A.D. 43, the Roman Emperor Claudius decided to conquer *Britannia*, as the island was then called. His legions easily defeated the Celtic tribes, and pushed on to the north and west. Boadicea, queen of a tribe called the Iceni, led a revolt in the early 60's, but the Romans crushed it. See Boadicea.

The Romans organized Britain as a province, and built many camps and forts. The Latin word for camp, *castra*, is the root of many English city names, such as Chester, Doncaster, and Gloucester. The Romans built roads linking their camps. One of the most famous of these roads ran from what is now Dover to the site of Chester, past the settlements that became Canterbury and London. This road is famous in history as Watling Street. The Romans also built a wall and a series of forts from coast to coast in the north to protect Britain from the warlike peoples of Scotland.

The country prospered during nearly 400 years of Roman rule. Trade spread along the military roads. New towns appeared around the fortified camps. London, then called *Londinium*, began to develop as a port. Christianity came to Britain for the first time during this period. According to legend, Joseph of Arimathea carried the Holy Grail with him, and traveled as far as Britain (see Glastonbury; Holy Grail).

The Germanic Invasions. Roman soldiers were called home from Britain in the early 400's to help defend Rome against barbarian invaders. The people who lived in Roman Britain could not protect themselves against tribesmen from Scotland called *Picts*, and invaders from Ireland called *Scots*. Seafaring Germanic tribes, including the Angles, Saxons, and Jutes, were an even greater danger. They made many raids along the coast. Then, in the A.D. 450's, they began making permanent settlements. The Jutes were probably the first to land, about 449. They settled in the southeast corner of England, called Kent. The other tribes followed, setting up tribal kingdoms throughout southern and eastern England. No one knows why the whole country became known as *Angle-land*. See Vortigern.

As the Germanic tribes swept into England, they gradually pushed the Britons farther and farther west. The Britons held out for a number of years under the leadership of a strong king. This leader may have been the real-life hero of the King Arthur legends. But the Britons were defeated again and again, until they held only the mountain regions of Cornwall (in the south), Wales, and Strathclyde (in the north).

Late in the 500's, England was converted to Christianity for the second time. Saint Augustine came from France to Kent in 597 and soon converted the king of the Jutes. Augustine built a church near Canterbury that became the forerunner of Canterbury Cathedral. At the time Augustine was preaching in southern England, Celtic missionaries converted the northern tribes, including the Picts and the Scots.

The Anglo-Saxon Period. The Germanic tribes were organized in small nations. The Jutes lived in Kent and around the Isle of Wight. Saxon settlers occupied southern England, and soon became divided into East Saxons, Middle Saxons, South Saxons, and West Saxons. Three of these tribal names became the names for the counties of Essex, Middlesex, and Sussex. The Angles settled northern and eastern England. Their nations were called Mercia, East Anglia, and Northumbria (for the people living north of the River Humber). East Anglia included the North Folk and the South Folk, now the counties of Norfolk and Suffolk. The Saxon word for home, *ham*, is preserved in such town names as Nottingham.

These tribal nations developed into seven separate kingdoms, and the period from about 500 to about 800 is called the time of the *heptarchy* (see HEPTARCHY). Three of the kingdoms, Northumbria, Mercia, and Wessex, dominated the island for about 100 years each.

In the 800's, Danish raiders began attacking the island. Wessex was the only kingdom that could resist the Danes. Alfred the Great, the king of Wessex, stopped them. He made a treaty ending the wars by dividing England with the Danes. The area under Danish rule became known as the *Danelaw*. Many city names that end in *tun* or *ton*, such as Wolverton, use the Danish word for town. Alfred was a good and wise ruler. His part of England became a united country. Many English institutions began to grow during Alfred's reign. He supported the church, encouraged education, and built the first English fleet. The *shire*, or county, became the unit of local government, and the common law developed in shire courts. The king's agent in each shire was called a *shire reeve*. The word *sheriff* comes from this title.

RED-LETTER DATES IN ENGLAND

A.D.43 Roman legions conquered Britain.
449 Angles, Saxons, and Jutes invaded the island.
597 St. Augustine brought Christianity to the Germanic tribes of southern Britain.
1066 Norman French forces conquered England after winning the Battle of Hastings.
1215 Barons forced King John to grant the Magna Carta.
1282 The English completed the conquest of Wales.
1295 Edward I summoned the Model Parliament.
1314 Scotland defended its independence at the Battle of Bannockburn.
1337-1453 England fought the Hundred Years' War with France and lost its lands on the continent.
1455-1485 Two royal families fought for the throne in the Wars of the Roses.
1534 Henry VIII separated the English church from the Roman Catholic Church.
1558-1603 Elizabeth I ruled during England's "Golden Age."
1588 English sailors defeated the Spanish Armada.
1603 England and Scotland were united under one king, James I.
1642-1660 Parliament overthrew Charles I and set up the Commonwealth, followed by the Protectorate.
1688 "The Glorious Revolution" deposed James II.
1689 Parliament passed the Bill of Rights.
1707 England and Scotland were united.
(For later dates, see GREAT BRITAIN [History].)

But, during the 100 years after Alfred died in 899, the Anglo-Saxon kingdoms became weak. The Danes gradually extended the Danelaw. Canute, younger brother of the King of Denmark, easily defeated Ethelred II, called *the rede-less* or *counsel-less*, the king of Wessex. Canute became ruler of England in 1016. He was a wise and just king, but his empire collapsed after he died. Edward the Confessor, son of Ethelred II, was the last great Saxon ruler of England.

The Norman Conquest. Edward the Confessor died in 1066 without a direct heir. English nobles chose Harold, a lord of Wessex, as king. But a Norman duke, William, grasped the opportunity to seize the throne. He landed an army in England and defeated Harold at the Battle of Hastings in 1066 (see HASTINGS, BATTLE OF). Before the end of the year, William the Conqueror was crowned king.

William built a strong central government in England. He divided the land among his Norman knights, and most of the Anglo-Saxons became serfs, bound to the land. But the Anglo-Saxons kept their language and many of their customs. That is why the English language often has two words (Norman and Anglo-Saxon) where other languages have one. The Saxon serf called his sheep or swine by Germanic names somewhat like the modern German *schaaf* and *schwein*. The Norman lord who ate the meat called the animals by their French names, *mouton* and *porc*. Thus, we now speak of *sheep* and *swine* on the farm and *mutton* and *pork* on the table. As the years went by, the Normans and Anglo-Saxons became a single people.

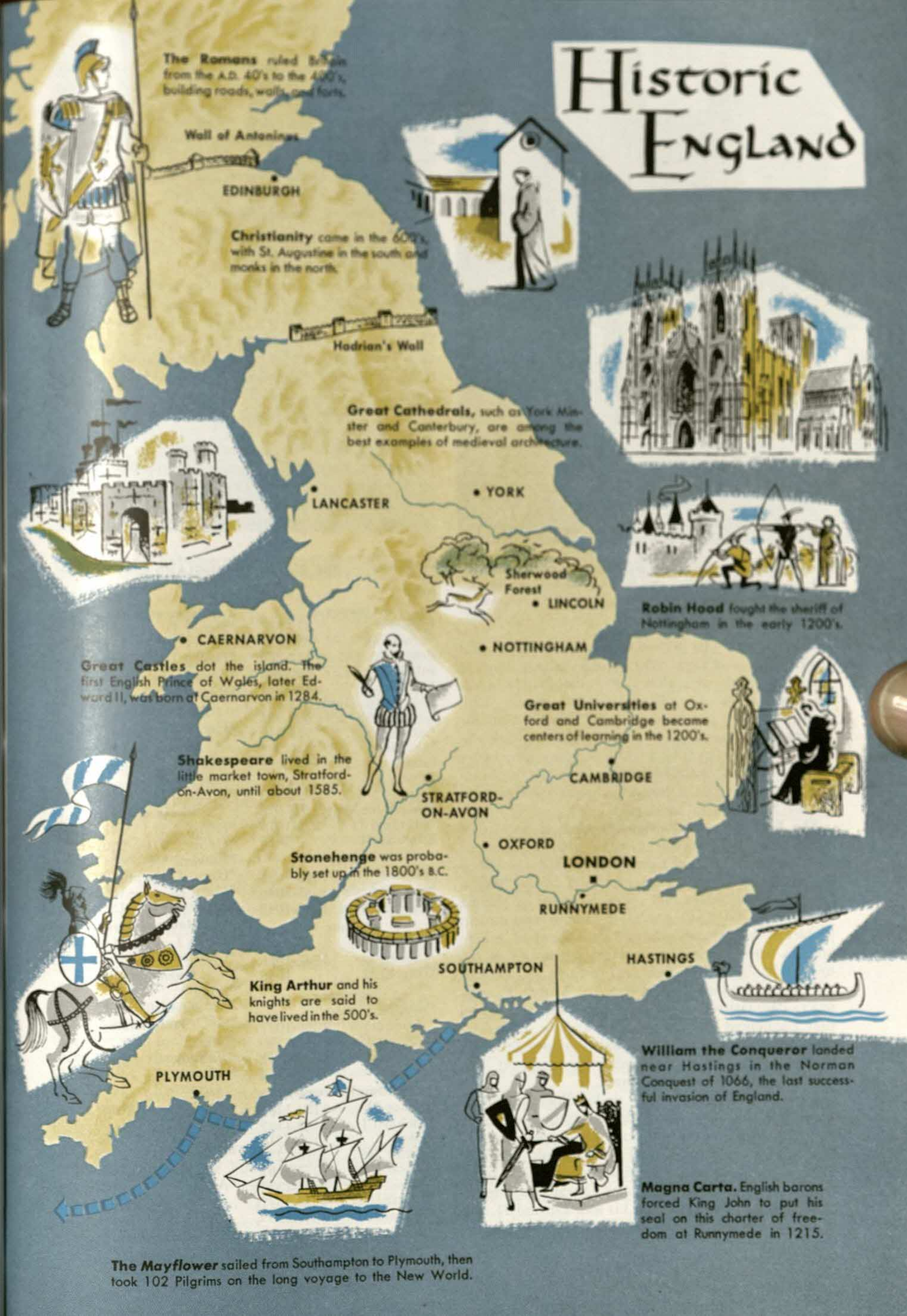
The Growing Kingdom. A struggle soon developed between the king and the nobles. Each noble wanted to build a castle and act like an independent ruler. Similar disputes took place in most European countries at about this time. But in England, unlike the other countries, the king won the first part of the struggle. Henry I strengthened the authority of the king. Later, in a long war during the reign of King Stephen, the nobles and clergy became almost completely independent.

Henry II restored the great administrative system that Henry I had built. He combined the Norman tradition of central authority with the Anglo-Saxon system of local rule. He gave authority to the royal courts and helped introduce the jury system. Henry spent much of his time in France, because he had inherited all the French provinces along the Atlantic coast from Normandy to the Pyrenees Mountains.

Henry's most famous conflict was with Thomas à Becket, Archbishop of Canterbury. The people were shocked when four of Henry's knights murdered Becket, and the king had to grant the clergy many special privileges (see BECKET, SAINT THOMAS À).

Magna Carta. Richard I (the Lion-Hearted) reigned for 10 years, from 1189 to 1199, but spent several of them outside England fighting in the Third Crusade (see CRUSADES). The country had to pay heavy taxes to support his armies. His brother John, who ruled during Richard's absence, was cruel, treacherous,

Historic England



The Romans ruled Britain from the A.D. 40's to the 400's, building roads, walls, and forts.

Christianity came in the 600's, with St. Augustine in the south and monks in the north.

Great Cathedrals, such as York Minster and Canterbury, are among the best examples of medieval architecture.

Robin Hood fought the sheriff of Nottingham in the early 1200's.

Great Castles dot the island. The first English Prince of Wales, later Edward II, was born at Caernarvon in 1284.

Great Universities at Oxford and Cambridge became centers of learning in the 1200's.

Shakespeare lived in the little market town, Stratford-on-Avon, until about 1585.

Stonehenge was probably set up in the 1800's B.C.

King Arthur and his knights are said to have lived in the 500's.

William the Conqueror landed near Hastings in the Norman Conquest of 1066, the last successful invasion of England.

Magna Carta. English barons forced King John to put his seal on this charter of freedom at Runnymede in 1215.

The *Mayflower* sailed from Southampton to Plymouth, then took 102 Pilgrims on the long voyage to the New World.

Gullers, Pix

Eton College Was Founded by King Henry VI in 1440, and remains on the original site. Eton has become one of England's most famous schools. It has trained many British leaders.

and cowardly. The legendary Robin Hood fought against John's officers. When John became king in 1199, the barons were already discontented. John lost his lands across the Channel after a dispute with France. He also quarreled with the Roman Catholic Church. The barons drew up a document called the *Magna Carta*, or Great Charter, which gave them many rights. In 1215, they forced John to agree to it (see MAGNA CARTA). Because of John's bad reputation, no later English king has used his name.

The Beginnings of Parliament go back to Anglo-Saxon times. But Parliament first became an important body during the reign of Edward I. Edward was willing to govern according to the principles of the Magna Carta. Previous kings had called meetings of leading churchmen and great nobles to discuss government problems. But Edward enlarged Parliament to include knights, lesser clergymen, and representatives of the towns. His *Model Parliament* met in 1295, and became the pattern for later Parliaments (see MODEL PARLIAMENT; PARLIAMENT). Two years later, Edward agreed that Parliament had the right to approve taxes proposed by the king before they could be collected. During Edward's reign, trade grew and towns prospered. The king strengthened the royal courts.

Edward I brought Wales under English control. There is a story that the Welsh chieftains cooperated with him after he promised that only a prince born in Wales, who could speak no English, would rule over them. Edward later gave the title *Prince of Wales* to his son, who had been born in Wales. Edward also tried to gain control of Scotland. But his son, Edward II, was beaten in the Battle of Bannockburn, and Scotland remained independent (see BANNOCKBURN, BATTLE OF).

England became important as a center of learning during the 1200's. A monk, Roger Bacon, was one of the leading philosophers of the time. Bacon also developed scientific methods of analyzing problems (see BACON, ROGER). Another monk, John Duns Scotus, is considered one of the greatest thinkers of the Middle Ages (see DUNS SCOTUS, JOHN).

The Hundred Years' War between England and France, from 1337 to 1453, resulted from England's growing trade. Edward III's mother was the sister of three French kings. Edward claimed the throne of France and landed an English army in Normandy. He won a brilliant victory at Crécy in 1346, and captured Calais the following year. His son Edward, called the Black Prince, won another great victory at Poitiers in 1356. The English troops used deadly *longbows*, while the French relied on armored knights and foot soldiers with *crossbows* (see CRÉCY, BATTLE OF; CROSSBOW). The English also used gunpowder, but it did not become common until the 1500's.

The English people opposed a long war in France. Parliament was unwilling to approve the heavy taxes needed to support the war. During the reign of Richard II, a blacksmith named Wat Tyler led a revolt of peasants that was put down by the king's troops (see

THE RULERS OF ENGLAND

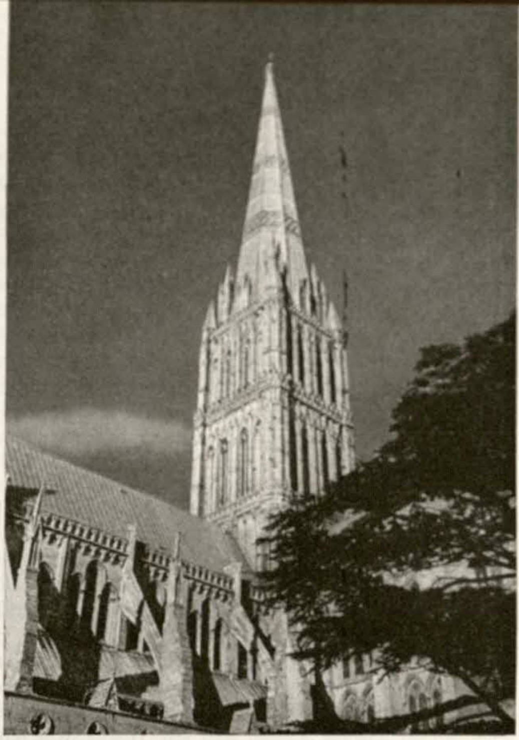
NAME	REIGN
Saxons	
*Egbert	829-839
*Ethelwulf	839-858
Ethelbald	858-860
Ethelbert	860-866
Ethelred I	866-871
*Alfred the Great	871-899
Edward the Elder	899-924
*Athelstan	924-940
Edmund I	940-946
Edred	946-955
Edwy	955-959
Edgar	959-975
Edward the Martyr	975-978
*Ethelred II	978-1016
Edmund II	1016
Danes	
*Canute	1016-1035
*Harold I	1035-1040
*Hardecanute	1040-1042
Saxons	
*Edward the Confessor	1042-1066
*Harold II	1066
Normans	
*William I, the Conqueror	1066-1087
*William II	1087-1100
*Henry I	1100-1135
*Stephen	1135-1154
Plantagenet Family	
*Henry II	1154-1189
*Richard I	1189-1199
*John	1199-1216
*Henry III	1216-1272
*Edward I	1272-1307
*Edward II	1307-1327
*Edward III	1327-1377
*Richard II	1377-1399
House of Lancaster	
*Henry IV	1399-1413
*Henry V	1413-1422
*Henry VI	1422-1461
House of York	
*Edward IV	1461-1470
House of Lancaster	
*Henry VI	1470-1471
House of York	
*Edward IV	1471-1483
*Edward V	1483
*Richard III	1483-1485
House of Tudor	
*Henry VII	1485-1509
*Henry VIII	1509-1547
*Edward VI	1547-1553
*Grey, Lady Jane	1553
*Mary I	1553-1558
*Elizabeth I	1558-1603
House of Stuart	
*James I	1603-1625
*Charles I	1625-1649
Commonwealth	
*Long Parliament	1649-1653
Protectorate	
*Oliver Cromwell	1653-1658
Richard Cromwell	1658-1659
House of Stuart	
*Charles II	1660-1685
*James II	1685-1688
*William III	1689-1702
and *Mary II	1689-1694
*Anne	1702-1714

(For rulers after 1714, see GREAT BRITAIN.)

*Has a separate article in THE WORLD BOOK ENCYCLOPEDIA.

Gullers, Pix

The Streets of Canterbury have changed little since Chaucer's time, in the Middle Ages. The cathedral dominates the city skyline.



British Travel Assn., Cushing

Salisbury Cathedral is one of the finest examples of English architecture of the 1200's. It is famous for its stately spire.

WAT TYLER'S REBELLION). Richard II demanded the right to rule without Parliament, but he governed so badly that the country turned against him. He was forced to abdicate (leave the throne), and Parliament chose the Duke of Lancaster to be king as Henry IV.

Henry IV spent much of his time fighting small wars against noblemen at home, and paid little attention to the war with France. But his son, Henry V, gained popular support for a new campaign in France. He won a great victory at Agincourt in 1415, and forced the king of France to accept him as regent and heir. But after Henry V died, the French defeated the English. Joan of Arc, who led the French, was captured by French allies of the English. They sold her to the English, and she was burned at the stake as a witch. But French successes continued, and soon the English held only Calais on the continent. See HUNDRED YEARS' WAR; JOAN OF ARC, SAINT.

Not all English activity in the 1300's was political. English poetry first became important during this period. William Langland wrote *The Vision of Piers Plowman*, often considered one of the first major poems in English. Geoffrey Chaucer helped shape the English language with such works as the *Canterbury Tales*.

A Struggle for the Throne began near the end of the Hundred Years' War. Henry VI of the House (family) of Lancaster was a feeble ruler, and the nobles of the House of York rose against him. The wars that followed were called the Wars of the Roses. York used a white rose as its emblem, and Lancaster displayed a red rose. Edward IV of York gained the throne from Henry VI in 1461. Henry regained the throne in 1470, but was deposed again in 1471, and Edward IV became king for the second time. His two sons were still children when he died. Edward's brother, Richard of York, imprisoned the two princes in the Tower of London, and some historians believe he had them murdered. He then proclaimed himself king as Richard III. Henry Tudor claimed the throne as heir of the House of Lancaster. He defeated Richard III on Bosworth Field and killed him. See WARS OF THE ROSES.

Henry Tudor became king as Henry VII. He determined to end the constant warfare between noble families. He married the heiress of the House of York, and put down the nobles with a firm hand. Henry also worked with Parliament, and respected the interests of the growing middle class. He strengthened his position by arranging marriages between his daughter and James IV of Scotland, and between his son and Catherine of Aragon (see CATHERINE OF ARAGON).

The English Reformation. Henry VIII inherited great wealth when he became king in 1509, because his father, Henry VII, had been extremely thrifty. Henry VIII was talented, but he was also selfish, vain, extravagant, and fond of sports and pleasures. He let Thomas Cardinal Wolsey manage the kingdom. When Henry wanted to divorce Catherine of Aragon, the first of his six wives, the Pope refused to consent. Henry threw Wolsey out. Then he ordered Parliament to declare that the king, not the Pope, was the supreme head of the Roman Catholic Church in England. This action occurred at about the same time as the Protestant Reformation on the Continent (see REFORMATION). English clergymen soon made changes in Roman Catholic services that eventually led to the establishment of the Church of England. Some Roman Catholics who opposed the king were beheaded for treason. A number of Protestants who doubted Henry's position as head of the church in England also lost their lives.

The work of establishing the Church of England went forward during the reign of Henry's only son, Edward VI. But Edward's half sister, Mary, the daughter of Catherine of Aragon, was a Roman Catholic, like her mother. When she became queen in 1553, Mary re-established Roman Catholicism as the state religion.

The Reign of Elizabeth I is often called "the golden age" of English history. Elizabeth came to the throne in 1558, when her half sister, Mary, died. She re-established the Church of England. Elizabeth was a vigorous but cautious ruler, and she played her enemies off against each other. Her adviser, Lord Burghley, followed a conservative policy, and England prospered.

More and more English ships crossed the oceans to distant lands. England broke Spain's power with the help of The Netherlands. King Philip II of Spain fitted out a huge fleet called the *Armada* to conquer England. But the Royal Navy, led by Admiral Lord Charles Howard, defeated the Armada, and storms wrecked many Spanish ships. This victory established England as a great naval power. See ARMADA.

After the defeat of the Armada, England entered a period of great development in every field. Traders set up the East India Company in 1600. Other seafarers such as Sir Francis Drake and Sir Walter Raleigh explored the West Indies and the coasts of Africa. Dramatists, including Shakespeare and Ben Jonson, and philosopher-statesmen such as Francis Bacon, marked England's greatness in many fields.

The First Stuarts. King James VI of Scotland was the heir to the throne when Elizabeth I died in 1603. He became James I of England. The two nations were joined in a *personal union* under one king, but they were ruled as separate kingdoms. English colonists established Jamestown and Plymouth in what are now the states of Virginia and Massachusetts. James I was not a popular ruler. Guy Fawkes' Gunpowder Plot was designed to kill him. The King quarreled frequently with Parliament because he wanted to rule as an absolute monarch (see DIVINE RIGHT OF KINGS).

Under James's son, Charles I, the struggle between the king and Parliament became even more bitter. Parliament forced Charles to agree to the Petition of Right in 1628, but he soon ignored it (see PETITION OF RIGHT).

The Civil War. Charles ruled as an absolute monarch, and did not call any Parliament from 1629 to 1640. When Parliament finally met, it refused to grant the king any funds until he agreed to limits on the royal power. Charles refused, and civil war broke out in 1642. Men who supported the king were called Royalists or Cavaliers. Parliament's greatest support came from the Puritans, who were called *Roundheads* because they cut their hair short. The Puritans closed the theaters and forced their strict beliefs on the people. Oliver Cromwell was one of the principal Parliamentary leaders. He led the Puritan army in a series of victories. Charles fled to Scotland, but the Scots turned him over to the Roundheads. A special court set up by Parliament condemned Charles to death. He was beheaded in 1649.

England then became a Commonwealth, or republic, ruled by a committee of Parliament. Oliver Cromwell ended the Commonwealth in 1653 by dismissing the *Long Parliament*, which had been meeting since 1640. The country was called a *Protectorate*, and Cromwell was called *Lord Protector*, but actually he was a dictator. He ruled until his death in 1658, and his son Richard was chosen protector.

The Restoration. Richard Cromwell could not handle the affairs of government. George Monk, a general who had served under Cromwell, marched from Scotland with his army and overthrew the government. Soon the Stuarts were restored as rulers of England.

Under Charles II, the country turned against the Puritans and their strict beliefs. But Parliament refused to give up the political powers it had won. Charles II avoided an open quarrel with Parliament, but James II wanted to restore Roman Catholicism and absolute rule for the king. The people were almost willing to let James have his way, because they expected his Protestant daughter, Mary, to succeed him. Above all, the people did not want another civil war. But when James had a son, the people realized that the son would make the Roman Catholic restoration permanent. Many people demanded that James abdicate. He fled to France in 1688. Parliament invited Mary and her husband, William of Orange, ruler of The Netherlands, to become rulers in 1689. It also passed an act that required the king and queen of England to be members of the Church of England. William and Mary took the throne in what is called "the Glorious Revolution" in English history. Parliament passed the Bill of Rights in 1689, assuring the people basic civil rights (see BILL OF RIGHTS).

Wars with France. France under Louis XIV had become the strongest power on the European continent. William had fought against France when he was Prince of Orange. As king of England, he made many alliances with other countries to keep France from growing too powerful. Mary II's sister Anne, who succeeded William in 1702, continued this policy. In the War of the Spanish Succession (called Queen Anne's War in North America), allied armies led by the Duke of Marlborough finally defeated France (see SUCCESSION WARS [War of the Spanish Succession]). In the peace settlement, England won the fortress of Gibraltar, a strategic outpost at the entrance to the Mediterranean Sea.

The Augustan Age. The reign of Queen Anne is often called "the Augustan Age," to compare it with the rule of Augustus in Rome. Alexander Pope, Jonathan Swift, Joseph Addison, and other authors made it a great period in literature. England's commercial prosperity grew. Parliament became the unquestioned supreme power in the country.

In 1707, the Act of Union made England and Scotland a single kingdom. The history of England thus became the history of Great Britain. For events since 1707, see GREAT BRITAIN (History). FRANCIS H. HERRICK

Related Articles. See GREAT BRITAIN with its list of Related Articles. See also the following articles:

BIOGRAPHY

An alphabetical list of biographies relating to England appears under the heading England in the BIOGRAPHY section of the READING AND STUDY GUIDE. See also the biographies of the rulers whose names are marked with an asterisk in the table, *The Rulers of England*, with this article.

CITIES AND TOWNS

Bath
Birmingham
Brighton
Bristol
Cambridge
Canterbury
Chester

Coventry
Dover
Durham
Glastonbury
Gloucester
Great Yarmouth
Hull
Leeds
Leicester
Lincoln
Liverpool
London
Manchester
Newcastle-on-Tyne
Nottingham
Oxford
Plymouth
Portsmouth
Salford
Salisbury
Sheffield
Southampton
Stoke-on-Trent
Stratford-on-Avon
Tewkesbury
Winchester
York

COLLEGES, SCHOOLS, AND UNIVERSITIES

Cambridge University
Charterhouse
Eton College
Harrow School
London, University of
Oxford University
Royal Academy of Arts
Rugby School
Shrewsbury School
Westminster School
Winchester College

HISTORY

See the HISTORY section of the READING AND STUDY GUIDE for detailed study outlines of the articles in WORLD BOOK which relate to the history of England. See also:

Anglo-Saxon
Buccaneer
Cabal
Colonial Life in America (Why the Colonists Came)
Coronation
Court of Common Pleas
Danegeld
Domesday Book
East India Company
England, Commonwealth of
Field of the Cloth of Gold
Guy of Warwick
Hampton Court Conference
Havelock the Dane
Hundred
Lancaster
Laud, William
Magna Carta
Norman
Norman Conquest
Plymouth Colony
Plymouth Company
Prince of Wales
Puritan
Reformation
Renaissance
Restoration
Roman Walls
Rump Parliament
Rye House Plot
Ryswick, Treaty of
Star Chamber
Stuart, House of
Test Act
Thane
Toleration Act
Tyburn Tree
Viking
Wat Tyler's Rebellion
Witenagemot
Yeoman
York

UNCLASSIFIED

Bodleian Library
Boxing Day
British Isles
British Museum
Church of England
Clothing
Cricket
English Language
English Literature
Fleet Prison
Flower (Flowers as Emblems)
Food (Customs)
Furniture
George, Saint
Hop
Music
Painting
Stonehenge
Sulgrave Manor
Tower of London
Westminster Abbey
Westminster Hall
Wight, Isle of
Windsor Castle

Outline

I. The Land
- A. Location, Size, and Surface Features
- B. Rivers and Lakes
- C. Islands

II. Life of the People
- A. The People
- B. Way of Life
- C. Cities

III. Social and Cultural Achievements
- A. Education
- B. Libraries and Museums
- C. The Arts
- D. Religion

IV. History (until 1707)

Questions

How does England compare in land area with your state or province?

How has England's island location affected the history of the country?

What is the chief difference between the public schools in England and the public schools in the United States?

Who were the first invaders of England? Who were the last invaders?

What is a *Bank Holiday?* The *primate of all England?* A *crossbow? The Wash?* A *pub?*

How does the official state church of England affect freedom of religion?

What was the importance of *the Armada?* Of the *heptarchy?* Of the *Model Parliament?*

ENGLAND, BANK OF. See BANK OF ENGLAND.

ENGLAND, COMMONWEALTH OF. England has been a kingdom for all but 11 years of its history. From the execution of Charles I in 1649 until Charles II became king in 1660, it was not a monarchy. Oliver Cromwell and his Parliamentary army held all power, first under the Commonwealth of England (1649-1653) and then under the Protectorate. Cromwell's death in 1658 speeded the return of the monarchy. W. M. SOUTHGATE

ENGLISH, BASIC. See BASIC ENGLISH.

ENGLISH CHANNEL is an arm of the sea which separates France and England. The French call the channel *La Manche*, meaning *the sleeve*. This channel is one of the world's most important waterways. It is about 350 miles long, and varies in width from 100 miles at the widest point to 20 miles at the narrowest place, between Dover, England, and Calais, France. It covers about 35,000 square miles, and is 200 to 300 feet deep. Geologists believe England and France were connected by land before the channel was formed.

The waters of the English Channel are often rough because the currents of the North Sea and the Atlantic Ocean meet in the channel. There are also frequent windstorms. The most important islands in the channel are the Channel Islands, off the French coast, and the Isle of Wight, off the southern coast of England.

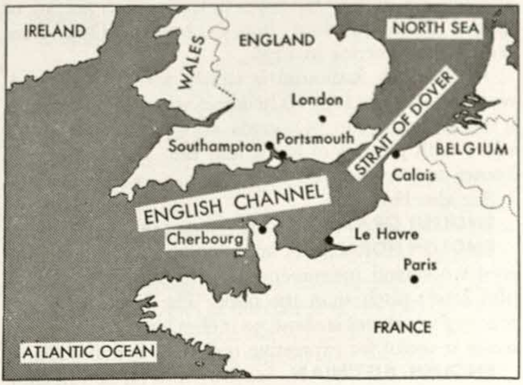
Important channel ports on the English coast are Dover, Falmouth, Portsmouth, and Southampton. On the French coast are Boulogne, Cherbourg, Dieppe, and Le Havre. Large amounts of shipping pass through the channel.

During the Allied invasion of Europe in World War II, Allied forces crossed the channel. Great oil and gasoline lines were laid across the channel to supply invasion troops.

Swimming the Channel is a challenge to very good swimmers. Recent record swims include that of Brenda Fisher of England, who in 1951 established a women's record of 12 hours and 43 minutes. Hassan Abd-el Rehim of Egypt swam the channel in 10 hours and 50 minutes in 1950 for a men's record. In 1958, Greta Anderson of California set a new England-to-France record of 11 hours. JOHN D. ISAACS

See also DOVER, STRAIT OF.

Location Map of the English Channel. This body of water is one of the busiest waterways anywhere in the world.



ENGLISH COCKER SPANIEL is a close relative of another cocker spaniel, sometimes called the American cocker. The English cocker is a popular hunting dog and companion in Great Britain and the United States. The English cocker is alert, well balanced, strongly built, and capable of high speed and endurance. It is noted for its intelligence, and is a responsible and willing dog, both in the field and as a companion. It differs from other cockers chiefly in size. It usually weighs from 26 to 34 pounds, or 6 to 8 pounds more than the American cocker. It has gradually become well known in the United States. See also DOG (color picture, Sporting Dogs). W. F. BROWN

Evelyn M. Shafer

The English Foxhound Is Often Used for Fox Hunting.

ENGLISH FOXHOUND is one of the oldest breeds of hounds. Careful breeding records, dating back to the 1700's, make it possible to trace the ancestry of some purebred English foxhounds through 50 to 60 generations. The breed derives from the staghound, the beagle, and the southern, or old English, hound. It has always been used for hunting foxes. The hounds run in packs, trailing the fox by the scent it leaves on the ground. Foxhounds are rarely kept as house pets, and do not have particularly interesting personalities. These dogs are not affectionate, and do not seem to want much petting or special attention from human beings. They were brought to America in 1738.

The English foxhound is sturdy and heavy-boned, with very straight legs. Its height is about 23 inches, and it weighs from 60 to 75 pounds. Its smooth, hard coat is white with patches of black and tan. This marking is known as *hound color*. JOSEPHINE Z. RINE

See also HARRIER.

ENGLISH GRAMMAR. See GRAMMAR.

ENGLISH HORN is not actually a horn, but a double reed woodwind instrument. It is an alto oboe with a fifth lower pitch than the oboe. The English horn is made of wood and is about 30 inches long. Its rich tones make it useful for expressive melodies. See also OBOE.

ENGLISH JUSTINIAN. See EDWARD (I) of England.

ENGLISH LANGUAGE is the language developed in England and now used throughout the British Commonwealth of Nations, in the United States of America, and in other parts of the world. Approximately 270,000,000 people speak the English language, according to some estimates. More people can speak English than any other single language of the world except Chinese. English is the native tongue of Americans, Canadians, Australians, New Zealanders, Liberians, and others, as well as of people of the British Isles. It also serves as a second language for many other people whose native tongue is not English.

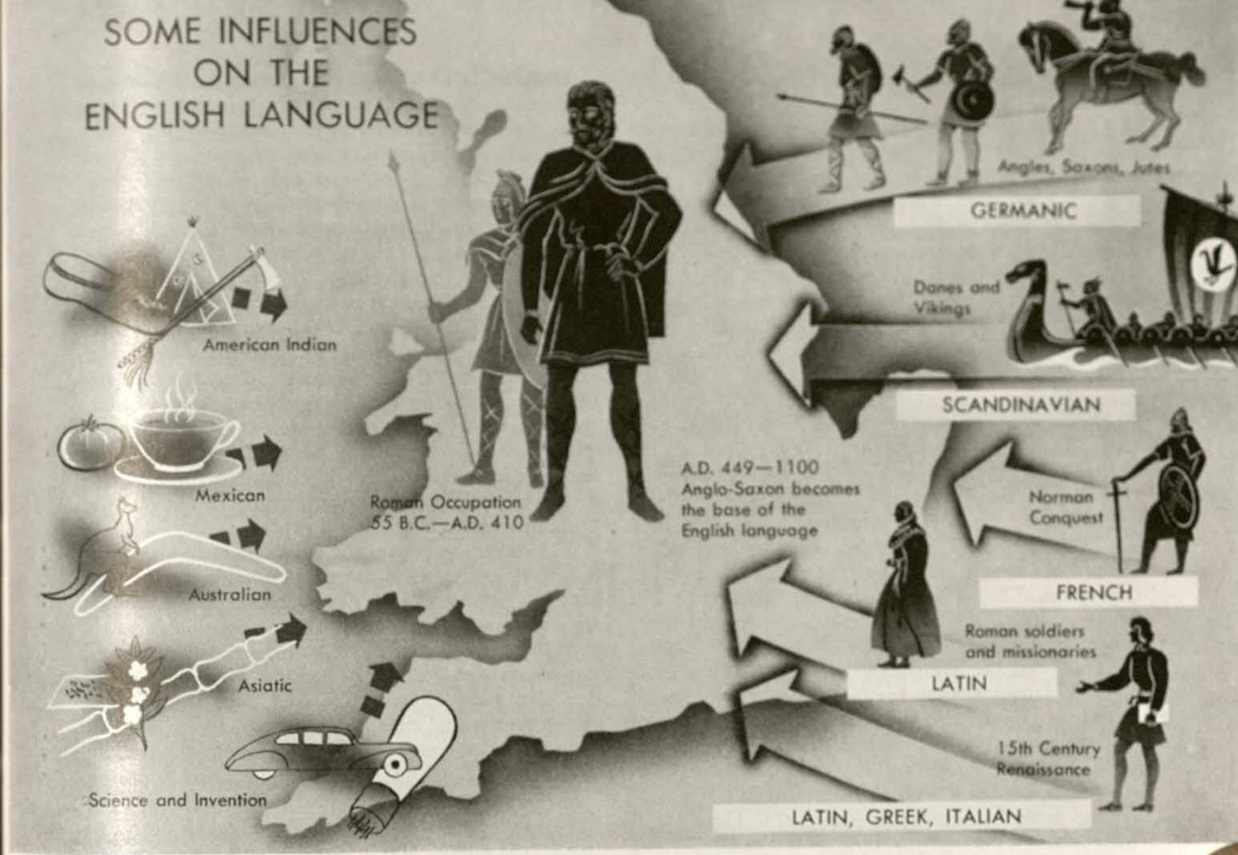
Modern English is composed of words from numerous sources. It has borrowed words from other languages ever since its beginning. No other language has adopted words so readily. This blending of native and foreign words gives power to the English language and makes possible a rich variety of expression. English has been compared to a mighty oak tree. The trunk and bare branches represent the native language forms. They give the language its simplicity, directness, and force. The leaves and blossoms represent the foreign element, which gives grace, variety, and ornament to the speech. The excellent blending of native and foreign elements gives the English language its great possibilities for richness and power. Even foreign language scholars admit that English is the *strongest* language spoken.

Beginnings. A group of people called Celts were the chief inhabitants of the British Isles until the 400's and 500's. They spoke various dialects of a language called Celtic. The Celts were conquered by the Romans first, and then later by several Germanic tribes. Perhaps no more than a dozen words remain in the English language from this original Celtic tongue. Among them are *bin*, *dun*, *crag*, and *tor*. But the Celts did leave their names for a number of places. England has hundreds of towns and cities with Celtic names, such as *Aberdeen*, *Dundee*, *Carlisle*, *Avon*, *Esk*, *Usk*, and *Dover*. In the same way, the American Indians left many names which are used for places in the United States. Examples include *Muskegon*, *Cheboygan*, *Mohave*.

The Romans ruled the Celts from 55 B.C. to about A.D. 410. But the Latin words remaining in the English language which can be traced to this period are few in number. The Romans gave their word for camp, *castra*, to dozens of towns and cities. The endings of *Chester*, *Winchester*, *Gloucester*, *Worcester*, and *Doncaster* are all modified spellings of this word. Modern English does contain a great many words of Latin origin. But these words were introduced later.

The real history of the English language begins about A.D. 450. Scholars divide this history into three periods: the *Old English*, or *Anglo-Saxon*, *Period*, from 499 to 1100; the *Middle English Period*, from 1100 to 1500; and the *Modern English Period*, from 1500 to the present. These dates are only approximate.

Old English (Anglo-Saxon) Period. The Germanic peoples from Europe who invaded England belonged to several tribes, Angles, Saxons, Jutes, and some Frisians. They conquered and settled the country over a long period, extending from about A.D. 449 to 550. Each tribe spoke its own language. But these dialects closely resembled one another and all belonged to a class of languages known as Low German. This class forms a part of a group of languages known as Teutonic, a



SOME INFLUENCES ON THE ENGLISH LANGUAGE

branch of the Indo-European family of languages. Thus English also belongs to the Teutonic group of languages, and its most immediate parent is the Low German language spoken today, called *Plattdeutsch*.

The Angles and Saxons finally took political control of most of England. Their speech, Anglo-Saxon, became the most widely used in England. It formed the basis for modern English. The more numerous Angles named their adopted land *Englaland*. They called their language *Englisc*, after *Angles* (Engle).

The Angles spoke the dialects called *Mercian* and *Northumbrian*. The dialect of the Saxons is known as *West Saxon*, and that of the Jutes as *Kentish*. Traces of these dialects can still be found in the speech used in various sections of England. Northumbrian was the form used by three of the most important early writers, Bede, Caedmon, and Cynewulf. Alfred the Great used West Saxon in his translations. This dialect also served the writers of the first history of the English people in their native tongue, the *Anglo-Saxon Chronicle*. It became the literary language. One of the oldest literary remains of the Old English period is the epic poem, *Beowulf*.

The invaders had few contacts with the Celts. Therefore there was almost no opportunity to learn their language. The Celts fled to the edges of the island, and some even went to what is now Brittany, in France. Many descendants of the Celts in Wales, Scotland, and Brittany still speak the Celtic tongue.

But the invaders had met the Romans on the continent of Europe. There they acquired a number of Latin words, such as *strata* (street), *vinum* (wine), and *campus* (field). They brought these with them to England. The mission of Saint Augustine, which introduced Christianity into England in 597, brought many other Latin terms and forms of grammar. They include, for example, the words *altar*, *bishop*, *candle*, *mass*, and *psalm*.

Another invasion of England took place about 850, this time by the Danes. Their speech belongs to the Teutonic group of languages, and so was closely related to that of the Anglo-Saxons. The Danes merged their language so successfully with Anglo-Saxon that it is difficult to trace the influence of Danish on English.

Anglo-Saxon, or Old English, used a great number of changes in the forms of words to indicate case, gender, tense, and other parts of grammar. Such a language is said to be *highly inflected*. Gender was fixed by rule, and not by meaning. For example, *woman* and *maiden* were neuter, *hand* was feminine, and *foot* was masculine. The Anglo-Saxons also tended to accent the beginning syllables of words. This often resulted in slurring the closing syllable, which must be pronounced distinctly in a highly inflected language to press the various forms. See INFLECTION.

Middle English Period (1100-1500). The conquest of England in 1066 by William, Duke of Normandy, had important effects on the English language. French was used in the upper classes, in the law courts, and in the schools for about the next three hundred years. Anglo-Saxon still served as the speech of the conquered people in their daily life. But it was kept alive only as a spoken language during this period. The careless tendency to slur the last syllable increased. The result was that the highly complex language of the Anglo-Saxons began to lose its inflections and become more simplified.

English began to emerge once more as a written language at the end of those years. But now it was greatly changed and much enriched. Most of its literary words and all of the terms relating to culture or to anything outside common speech had to be borrowed from the French. The English tongue absorbed practically all the French of the conqueror in this way.

The Middle English period was one of change, marked by confusion and the absence of any standard English tongue. All writers wrote in the dialect they knew. Men of one section of the country could not understand the dialect of another. Three distinct dialects were spoken, the *Northern*, *Midland*, and *Southern*. Geoffrey Chaucer, the greatest Middle English poet, used the Midland dialect. His genius made it the standard form of the tongue and the parent of modern English. Grammatical forms became simpler, and English lost nearly all its inflections. This tendency in grammar has continued up to our own day. It has made English grammar easier to learn than that of almost any other major language. English has often been recommended as an international language for this reason. A group of specially selected words to serve such a purpose is known as *Basic English* (see BASIC ENGLISH).

Modern English Period. Modern English began to develop with the opening of the 1500's. The Renaissance added a considerable body of Latin, Greek, and Italian words to the language. English traders and colonists borrowed words from lands in every continent and added them to the language. They adopted such words as *moccasin*, *tomahawk*, and *wigwam* from the North American Indians. *Canoe* and *hurricane* came from the West Indies. Mexico contributed *chocolate* and *tomato*. *Canary* and *guinea* were taken from African tribes. Australia lent *boomerang* and *kangaroo*. *Tea* and *nankeen* came from China and *bamboo* and *gutta-percha* from the Malays. Science and invention have also contributed to the language. Such terms as *hectograph*, *automobile*, *radar*, *electronics*, and *motorcycle* are examples of words coined to meet new conditions. Wars produce new words, such as *camouflage*, *quisling*, and *blitzkrieg*.

No one uses more than a fraction of the 400,000 to 600,000 English words in existence. Shakespeare used only about 15,000, and Browning some 38,000. Persons who cannot read probably know only a few hundred words. Those with an average education do not know more than a few thousand. Everyone who reads has two vocabularies. Those words which he merely recognizes make up his *passive* vocabulary. His *active* vocabulary, used in speaking and writing, is much smaller. Because words are the signs of ideas, it is important to develop as large a vocabulary as possible.

CLARENCE D. THORPE

Related Articles in WORLD BOOK include:

Basic English
Celt
Dictionary
England (Norman Conquest)
Etymology
Grammar
Language
Philology
Pidgin English
Pronunciation
Spelling

ENGLISH LAUREL. See CHERRY LAUREL.

ENGLISH LITERATURE. Englishmen have expressed themselves with greater ease and force in literature than in any other art. For over a thousand years their literature has had no equal in variety, quantity, and general excellence. English literature reflects in great detail the development of English civilization. Every period of English history has been represented by its great writers and critics. Critical events of English history have always stirred English writers deeply.

As England extended its trade and its colonies, the English language spread to all parts of the world. English literature thus became known wherever English was spoken. Its influence became especially noticeable in the United States. Because Americans speak English, they share the great literary wealth of Englishmen. They have also made important additions to it. American literature and English literature have often shown a close relationship, and certain writers can be claimed by both nations.

The continuous vigor of English literature is due to a number of unusually favorable circumstances. England lies near enough to Europe to keep close contact with European civilization. Yet its position as an island has spared it from long periods of domination by foreign peoples. Its history has also been remarkably free from social violence. England, like America, has shown an unusual capacity to accept change and absorb new elements. This ability becomes especially evident in the English language. See ENGLISH LANGUAGE.

Certain themes run through English literature from the Middle Ages to the present. Among these are a love of glory, of nature, and of freedom and justice, as well as a deep religious feeling.

Historians usually divide history into periods to make dates and events easier to remember, but they do not always agree as to how these divisions should be made in the history of English literature. No sudden breaks occur between one period and the next.

The Anglo-Saxon Period (500-1066). The oldest literature of England reflects the life lived by the warrior tribes from Europe who invaded the island. The tribes of the Angles and Saxons soon took control of most of the land. The period during which they ruled is known as the Anglo-Saxon, or Old English, period. Little is left of the earliest battle songs these people sang before they became Christians. But the oldest Anglo-Saxon literature tells us much about them. The finest of this literature is poetry, written in epic style. It pictures their heroes and reflects their deep feeling for nature. It also shows that they did not entirely forget their old gods and myths after they accepted Christian beliefs.

The greatest Anglo-Saxon poem is *Beowulf*, an epic that may have been written sometime between 600 and 800. It tells of the courage and the strength of a Scandinavian hero. Beowulf became king after winning honor by defeating monsters. He finally died fighting a dragon.

Shorter poems in Old English include lyrics, war songs, and the Christian poetry of Caedmon, Cynewulf, and writers whose names are now unknown.

Anglo-Saxon words had many changes of form and numerous different endings. This quality made the language unsuitable for poetry written in rhyme or regular meter. Instead, the poets stressed accent and repeated the beginning sounds of words, instead of end sounds.

The principal works in prose of this period were the *Anglo-Saxon Chronicles*. These form the earliest surviving record in the native tongue of any nation of Western Europe. They exist in six forms, all differing in content and length. Monks put the chronicles together. The work was carried on in various monasteries, especially those at Winchester, Canterbury, and Peterborough. Some versions begin with 60 B.C., the date of Julius Caesar's invasion of England, according to The Venerable Bede, church historian of the 700's. A few of the accounts are continued into the 1100's. Alfred the Great is supposed to have inspired the work, and may even have written the part down to 892. Only the bare dates exist of some events, but others have interesting descriptions.

The Anglo-Norman Period (1066-1350). The Normans brought the language and culture of France with them when they settled in England in 1066. The upper classes used French for the next three hundred years, but the common people continued to speak English. Most of the literature was written in French during this time, and what few works were written in English showed the French influence. Works of scholarship and religion continued to be written in Latin. A number of noble hymns still sung today were written then. But some popular compositions of a religious character appeared in English. Among them were the religious poem, *The Prick of Conscience*, and the *Cursor Mundi*, an account in verse of the history of the world. A beautiful poem called *The Pearl* is another example.

Romantic poems glorified the adventures of knights and other heroes of chivalry. These poems were composed in both French and English, and form the characteristic literature of the period. Both Anglo-Saxons and Normans loved to hear the tales sung by the minstrels. But the life described in the Norman romances differed greatly from the rude dignity of the civilization pictured in *Beowulf*. The Norman heroes appeared as knights whose deeds were chivalrous, if not always true to history. Great series of poems were composed about such heroes as Alexander the Great and Charlemagne. Two romances of the period are among the finest in English, *Sir Gawayne and the Green Knight* and Layamon's *Brut*. These and other poems helped to make King Arthur, a minor chieftain among the early Britons, into a national hero.

The Age of Chaucer (1350-1400). The poetry of Geoffrey Chaucer marks the high point of English literature during the Middle Ages. His greatest work, *The Canterbury Tales*, includes almost every type of story popular at the time. These lively tales give exact descriptions of the people of that day.

Some of the writers living during the time of Chaucer showed another view of the times. The people suffered poverty, and blamed the government and the Church for their misery. John Wycliffe wrote sermons and articles and sent priests to preach to the people in their own language. He also translated the Bible into English. A powerful poem called *The Vision Concerning Piers Plowman*, by an unknown author, set forth the wrongs of the time in the form of allegory. John Gower (1325?-1408), a friend of Chaucer, expressed the attitude of the ruling class toward the rebellious peasants. He was regarded as the equal of Chaucer in his own time.

Many writers of the 1400's imitated Chaucer. The finest compositions were many popular ballads and an account in prose called *Le Morte Darthur*, by Sir Thomas Malory. It tells of the adventures of King Arthur and his knights.

The Tudor Period (1485-1603). The 1400's and 1500's brought many changes which greatly influenced English culture. Printing was invented, and America was discovered. A new religious feeling expressed itself in the Protestant Reformation. Interest in learning rapidly increased with the rediscovery of Greek and Roman works of literature and philosophy.

Englishmen took pride in their nation and showed it in their deeds of enterprise and daring. Their literature reflects this spirit in various forms. It shows a new concern for human personality. The people of the Middle Ages had thought chiefly of the salvation of their souls. This new concern appeared in the educational works of Thomas Elyot, Roger Ascham, and others. Much of the prose of this period pictures the elegant manners then in fashion. The writings of Sir Philip Sidney are typical examples, especially his romance called *Arcadia*. John Lyly set forth the rules for behavior at court in *Euphues*. But other writers, such as Robert Greene, Thomas Lodge, and Thomas Nashe, produced romances that were closer to reality. The end of this period is sometimes called the *Elizabethan Age*.

New literary forms were experimented with. The introduction of blank verse and the sonnet brought richness and variety to some of the poetry. Many of the most beautiful lyrics and love songs in English belong to this period. They were often written by men of affairs like Sidney and Sir Walter Raleigh, rather than by professional writers. The finest of the longer poems were those of Edmund Spenser. He wrote in the literary style of an earlier period and used the age of chivalry as a setting for his works. But many of his characters represent national heroes of his own time and his works reflect the political and moral ideals of that period. His best known work is the romantic epic, *The Faerie Queene*, but his pastoral poem, *The Shepheards Calender*, is also famous.

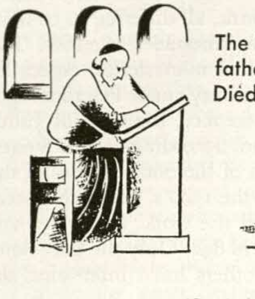
The Tyndale-Coverdale translation provided a Bible the people could read and understand. This work and the English Book of Common Prayer inspired new religious feeling. The best English prose of the period is found in the King James, or Authorized, version of the Bible, published in 1611.

The greatest literature of the period was that written in the form of drama. Religious plays had been popular in England since medieval times. These productions often took place outside the church as time went on, and became more popular in character (see DRAMA; MIRACLE PLAY; MORALITY PLAY). Such plays and the newly revived knowledge of Greek and Roman drama served as rich material to inspire the playwrights. Popular enthusiasm for the drama created a demand for new plays. Talented writers wrote plays for professional companies of actors. As a result, one of the richest dramatic literatures of the world was produced. The finest of all these dramatists was William Shakespeare. (See SHAKESPEARE, WILLIAM.) But many others of his time were among the greatest playwrights in English literature. One of these, Christopher Marlowe, wrote

ENGLISH LITERATURE FROM THE 600'S TO THE 1600'S

Beowulf,
the oldest
English epic
About A. D. 600

Caedmon,
the monk who
sang God's praises
A. D. 680



The Venerable Bede,
father of English learning
Died A. D. 735

Alfred the Great,
savior of culture
A. D. 849-901

1300 '25 '50 '75 1400 '25 '50 '75 1500 '25 '50 '75 1600 '25 '50

LANGLAND Poet of the poor

CHAUCER The morning star of poetry

The monk of Bury **LYDGATE**

Teller of tales of the Round Table **MALORY**

First printer in England **CAXTON**

Brightest of the century **HENRYSON**

Author of *Philip Sparrow* **SKELTON**

Humanist, scholar, statesman **MORE**

Lyric poet and diplomat **WYATT**

With Wyatt, father of the sonnet **SURREY**

The poet's poet supreme **SPENSER**

Elegance in prose and drama **LYLY**

Gentleman and critic **SIDNEY**

Learned scientific prose **BACON**

Thunder in his lines of verse **MARLOWE**

The greatest of all **SHAKESPEARE**

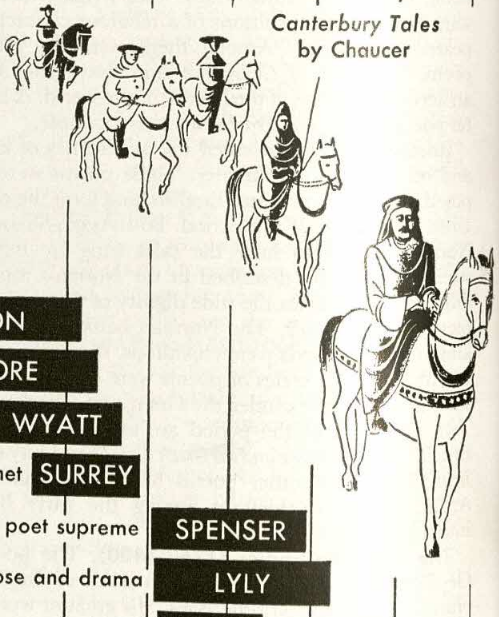
Fun-loving dramatist **DEKKER**

O rare Ben Jonson! **JONSON**

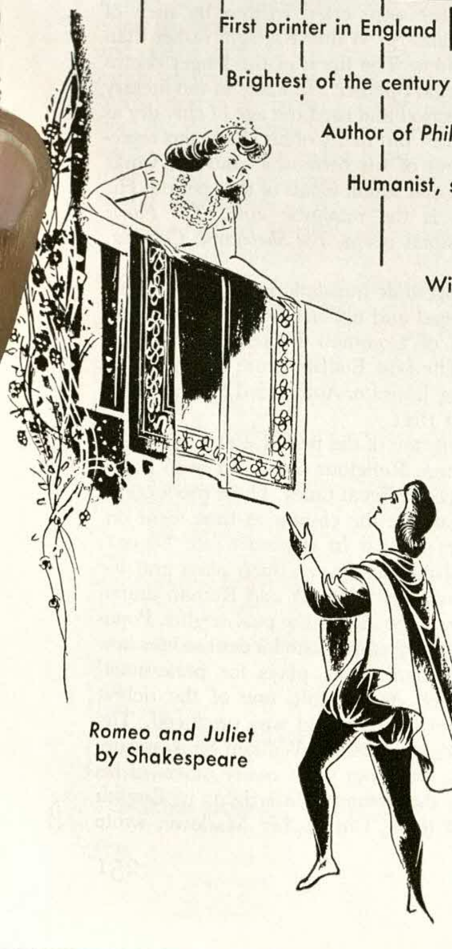
"Metaphysical" verse **DONNE**

The best writing team **FLETCHER** **BEAUMONT**

Great tragic dramatist **WEBSTER**



Canterbury Tales
by Chaucer



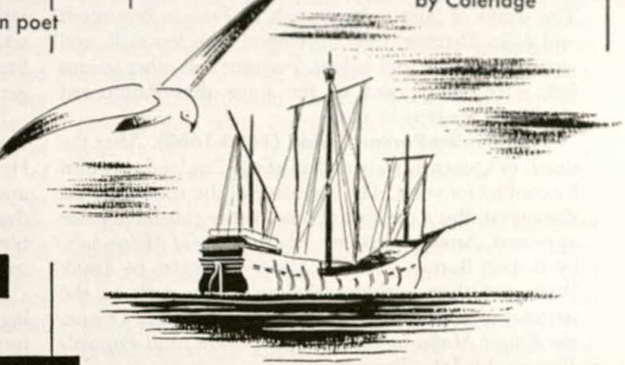
Romeo and Juliet
by Shakespeare

ENGLISH LITERATURE FROM THE 1600'S TO THE 1900'S

1600 '25 '50 '75 1700 '25 '50 '75 1800 '25 '50 '75 1900 '25 '50

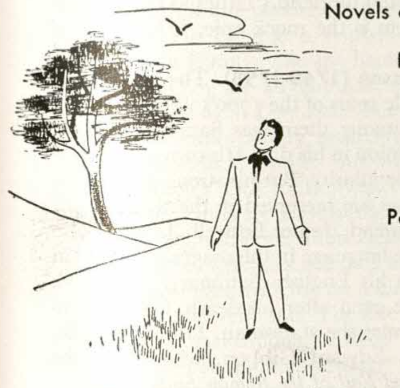
King James Bible written between 1604 and 1611. A monument of prose

Great, gifted Puritan	MILTON
Leading Restoration poet	DRYDEN
Robinson Crusoe	DEFOE
Satire and pessimism	SWIFT
Sir Roger de Coverley	ADDISON
Symbol of Classicism	POPE
The first real novelist	RICHARDSON
Greatest novelist of his time	FIELDING
Literary dictator	JOHNSON
Mystical nature poet	WORDSWORTH
Novels of the Middle Ages	SCOTT
Poet of the fantastic	COLERIDGE
Essays of charm	LAMB
Sad and romantic verse	BYRON
Poet of skylarks and winds	SHELLEY
Greek themes and beauty	KEATS
Philosopher of supermen	CARLYLE
Lyric and romantic verse	TENNYSON
Humorous satiric novelist	THACKERAY
Novels of English life	DICKENS
Poet of optimism	BROWNING
Essayist on art	RUSKIN
Philosophical novels	GEORGE ELIOT
Poet of troubled doubt	ARNOLD
Novels of the heath country	HARDY
Satirical dramatist	SHAW
Mystical Celtic poet	YEATS
Dramas and novels of today	GALSWORTHY
Novels of the inner mind	JOYCE
Most sensitive of stylists	WOOLF
Poet of modern wastelands	T. S. ELIOT

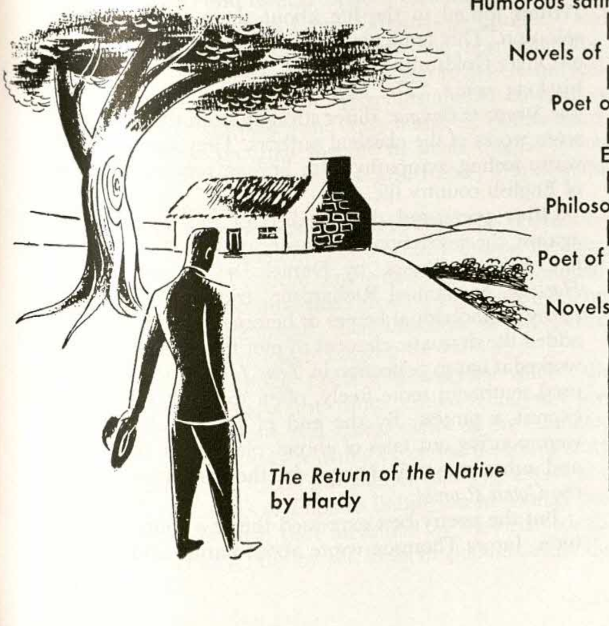


"The Ancient Mariner"
by Coleridge

The Idylls of the King by Tennyson



"To a Skylark" by Shelley



The Return of the Native by Hardy

brilliant plays before he died at the age of twenty-nine. The learned friend of Shakespeare, Ben Jonson, was also his chief rival. Jonson disapproved of the romantic plays of the day which did not follow the classic form of ancient drama.

The drama gradually declined after Shakespeare. The works of later writers, such as Francis Beaumont and John Fletcher, were developed with less skill, and were often coarse and vulgar. Puritans and other serious folk were so opposed to the stage that Parliament closed the theaters in 1642.

The Cavalier-Puritan Period (1606-1660). After the death of Queen Elizabeth I in 1603, England was torn by conflict for years. The literature of the 1600's reflects this unrest. But a number of noteworthy classics in prose appeared. Among them are *The Anatomy of Melancholy*, by Robert Burton, and *The Compleat Angler*, by Izaak Walton. Others include religious works such as the writings of Jeremy Taylor, the sermons of John Donne, the *Religio Medici* by Sir Thomas Browne, and *Pilgrim's Progress*, by John Bunyan.

The poetry shows a variety of interests and styles. Some poets, like Phineas Fletcher and William Browne, wrote allegories in the manner of Spenser. Others wrote love poems which showed the influence of Ben Jonson. Among them were Thomas Carew (1595?-1639?), Robert Herrick (1591-1674), Richard Lovelace (1618-1658), and Sir John Suckling (1609-1642), called the *Cavalier poets*. John Donne (1573-1631) and his followers, Richard Crashaw (1613-1649), George Herbert (1593-1633), and Henry Vaughan (1622-1695), wrote religious poems with striking figures of speech. They were known as the *Metaphysical poets*.

By far the greatest literary figure of the age was John Milton. He is often regarded as the greatest English poet after Shakespeare. His prose work *Areopagitica* is a classic defense of the freedom of the press. After he lost his sight he returned to poetry and produced *Paradise Lost*. This work contains some of the finest blank verse in English.

The Restoration Period (1660-1700). After the downfall of the Puritan Commonwealth in 1660, England restored its king, Charles II. The period is the *Restoration*. Writers were free to ignore or to ridicule Puritan morals. Samuel Butler wrote a satire on Puritanism in his poem, *Hudibras*. A number of witty plays by William Congreve, William Wycherley, and other dramatists exhibited the loose morals of court society. But a taste for perfect form and smooth style developed from the influence of French literature, which had been gained while the courtiers were exiled in France.

The most important writer was John Dryden. He wrote most of his poetry in a form of verse made up of two rhymed lines of ten syllables each. This form is called the *heroic couplet*. This couplet became the fashion in English poetry for two generations. It was particularly effective for political satire, such as "Absalom and Achitophel" by Dryden, and for epigrams. Dryden also used it for his translation of Virgil's *Aeneid* and in his plays. But some of his finest poetry was not in couplets. His greatest play, *All for Love*, was in blank verse. He also developed the short, flexible sentence of modern English in his critical essays.

The Age of Swift and Pope (1700-1740). The writers of the early 1700's tried to achieve finish, grace, and what they considered to be a correct style. New or individual subject matter concerned them less. The rule of Queen Anne had raised conduct from the low plane to which it had fallen during the Restoration period. Common sense, good judgment, and good taste became the standards. Religion was tested by reason, rather than by authority or by experience. This new set of conventions influenced the essays of Sir Richard Steele and Joseph Addison. Addison, especially, used gentle irony to teach good manners.

Much more vigorous and brilliant satire came from the harsh wit and bold imagination of Jonathan Swift. He wrote *Gulliver's Travels* as an attack upon the follies and sins of his day. His criticism had less effect than that of Addison, because Swift showed his personal bitterness. But he told such a good story that it has remained a popular classic for children.

Poetry was as much used for satire and philosophy during this period as it had been in the Restoration. It was usually written in heroic couplets. The greatest master of these essays in verse was Alexander Pope. He translated and adapted the works of earlier poets as Dryden had done. His "Essay on Criticism" sets forth the literary theory of the early 1700's. In "The Dunciad" he ridiculed other writers and unfriendly critics as dunces. His most charming poem is the mock epic, "The Rape of the Lock."

The Age of Johnson (1740-1798). The intellectual leaders of the middle years of the 1700's were the classical writers. Chief among them was Samuel Johnson, who dominated opinion in his day. His own works have lost much of their popularity. But his strong personality and his critical views are preserved in the timeless *Life of Johnson* by his friend, James Boswell. Johnson also attempted to fix the language in the usages approved in the 1700's through his English dictionary. This work had wide influence even after his death. Other members of the group were the statesman, Edmund Burke, and the historian, Edward Gibbon, who wrote the scholarly *Decline and Fall of the Roman Empire*.

Classic writing lost favor as the century wore on. Writers turned to the life about them for fresher inspiration. This tendency shows especially in the work of Oliver Goldsmith. His novel, *The Vicar of Wakefield*, his long poem, "The Deserted Village," and his play *She Stoops to Conquer* differ strongly from the common-sense works of the classical authors. They show instead warm feeling, sympathy with human nature, and love of English country life.

Other poets and the novelists of the time reacted against the restrictions of classic writing. Early novels like *Robinson Crusoe*, by Daniel Defoe, and *Clarissa Harlowe*, by Samuel Richardson, tried to arouse sympathy for individual heroes or heroines. Henry Fielding added the dramatic element of plot to this interest, and worked it out to perfection in *Tom Jones*. Later novelists used sentiment more freely, often to teach a lesson or express a protest. By the end of the 1700's, authors were pouring out tales of ghosts, old castles, dungeons, and other romantic horrors in the movement called the *Gothic Revival*.

But the poetry best expressed the new romantic attitude. James Thomson wrote about nature and English country life in a long poem, "The Seasons." This new sympathy finds expression in Thomas Gray's "Elegy Written in a Country Churchyard." The hundreds of songs by the Scottish poet, Robert Burns, also show the romantic feeling of the time. Such works pointed the way to a brilliant new period of romantic poetry.

The Age of Romanticism (1798-1832). The romantic spirit reached its height at the close of the 1700's and in the early 1800's. The practice of writing literature in the romantic style is referred to by the term *romanticism.* William Wordsworth and Samuel Taylor Coleridge led the movement, and first gave it publicity in *Lyrical Ballads*, a collection published in 1798. They announced their principles in a preface to the second edition of *Lyrical Ballads*, published in 1800. The poems of Wordsworth interpret the beauty and hidden meanings in the world of nature. Excellent examples are his short lyrics, and longer poems such as "Tintern Abbey" and the "Ode: Intimations of Immortality." Coleridge's romantic imagination led him to picture strange events in such masterpieces as "The Rime of the Ancient Mariner," "Kubla Khan," and "Christabel."

The romantic spirit had little patience with conventional ways of thinking and living. The younger romantic poets expressed this view in both their writings and their actions. George Gordon, Lord Byron, gave his life for Greek independence after a stormy series of adventures. He became a symbol of romantic heroism throughout Europe, and the heroes of his poems resemble him. They are adventurers, as in *Childe Harold*, or social rebels, as in *Don Juan*. Percy Bysshe Shelley also expressed revolutionary sympathies in "Queen Mab" and *Prometheus Unbound*, but with more control and skill. Shelley's "Ode to the West Wind," "To a Skylark," and other poems are some of the finest lyrics in English.

One romantic poet, John Keats, loved beauty more than all other qualities. He died at twenty-five, yet such perfect poems as his "Ode on a Grecian Urn," "La Belle Dame sans Merci," and "The Eve of Saint Agnes," have won him a place among the finest English poets. He had great influence on later writers.

The representative prose writers of the period were the essayists and critics. Besides Coleridge, there were such men as Charles Lamb, Thomas de Quincey, and William Hazlitt. Lamb is perhaps the most appealing. He made of the essay a delightful record of personal feeling and of gentle humor. Two outstanding novelists of the early 1800's were Jane Austen and Sir Walter Scott. Jane Austen pictured the life in small English towns with gentle satire. Romance and history inspired the novels of Scott.

The Victorian Period (1832-1900). The population and wealth of England grew rapidly during the long rule of Queen Victoria. Trade and industry developed. Interest in science increased greatly, and democracy became more widespread. The literature of the period brilliantly reflects these changes.

The most popular poets and essayists voiced the hopes and ideals of the times. Alfred Tennyson presented the religious and moral views of the educated Englishman. Robert Browning expressed the strong tendency to look on the bright side of life. The essays and historical writings of Thomas Babington Macaulay presented the English past measured by Victorian ideals. Thomas Henry Huxley set forth in popular form the findings of Victorian scientists, especially Charles Darwin's theory of evolution.

Rich variety marks Victorian literature, especially the novels. The three principal novelists of the middle 1800's were William Makepeace Thackeray, George Eliot, and Charles Dickens. Thackeray ridiculed English social life. George Eliot pointed morals in her works. Dickens won a world audience with his broad human sympathies. The chief novelists of the later 1800's were George Meredith and Thomas Hardy. They were also distinguished poets, deeply concerned with the place of man in the world of nature. Romance and high adventure mark the widely popular novels of Robert Louis Stevenson.

Another group of authors found the spirit of the times shallow and too much concerned with material things. They turned to the past for inspiration or expressed their displeasure through criticism. Thomas Carlyle exposed the faults and pretenses of middle-class thought. English social life appeared coarse and narrow to Matthew Arnold, and he pleaded for a return to Greek standards. John Ruskin combined art criticism with social comment in the interests of a new society to be based upon spiritual values. Cardinal Newman and some of his admirers turned to the authority of the Roman Catholic Church. Oscar Wilde wrote plays full of sparkling epigrams, and the profoundly moving "Ballad of Reading Gaol." One group of poets and painters tried to recall the spirit of the Middle Ages, and were known as the *Pre-Raphaelites*. Others, like Algernon Charles Swinburne and Walter Pater, turned to classical or Renaissance subjects for inspiration.

After 1900, many Victorian ideas lingered on until World War I. But some writers began to express new attitudes in the first years of the 1900's. Perhaps the bitterest direct literary attack came in *The Way of All Flesh*, a novel by Samuel Butler. But the novels of Arnold Bennett and John Galsworthy and the plays of Galsworthy and George Bernard Shaw also reflect the shortcomings and failures of English society. A different tendency marks the works of other writers. The novels of Joseph Conrad, the stories of Rudyard Kipling, and the novels and plays of Sir James Barrie are concerned chiefly with adventure and romance.

The shock and suffering of World War I and the economic depression that followed brought many changes to England. But these produced no immediate effects on literature beyond a new tone of bitterness and doubt and more experiments with language and form. The literary criticism of T. S. Eliot, I. A. Richards, and others, stimulated such experiments. New discoveries in psychology, especially those of Sigmund Freud, led other writers to experiment with novels which explore the hidden processes of the human mind. The outstanding authors of psychological novels are D. H. Lawrence, Virginia Woolf, and James Joyce. Lytton Strachey and other writers tried to interpret the lives of famous persons through psychological analysis. Thus biography began to resemble fiction more than history.

Poets also began to experiment with new forms. Such experiments appear especially in the writings of T. S. Eliot, Edith Sitwell, C. Day Lewis, W. H. Auden, and Stephen Spender. The finest work in the traditional style came from the older poets, Robert Bridges and William Butler Yeats. A young Welsh poet, Dylan Thomas, developed an individual and strongly personal blend of traditional and experimental forms and language.

FRED B. MILLETT

Related Articles. See the LITERATURE section of the READING AND STUDY GUIDE for a detailed list of articles on English literature, and the list of Authors in the BIOGRAPHY section. See also the following articles:

American Literature
Biography
Canadian Literature
Diary
Drama
Essay
Fiction
Literature
Literature for Children
Novel

Outline

I. **The Anglo-Saxon Period (500-1066)**
II. **The Anglo-Norman Period (1066-1350)**
III. **The Age of Chaucer (1350-1400)**
IV. **The Tudor Period (1485-1603)**
V. **The Cavalier-Puritan Period (1606-1660)**
VI. **The Restoration Period (1660-1700)**
VII. **The Age of Swift and Pope (1700-1740)**
VIII. **The Age of Johnson (1740-1798)**
IX. **The Age of Romanticism (1798-1832)**
X. **The Victorian Period (1832-1900)**
XI. **After 1900**

Questions

Who wrote the biography of Samuel Johnson?
Why is English literature so widely known?
What is Chaucer's most famous work?
Why did Parliament order all theaters closed?
What book by Defoe is still widely read?
How does Milton rank among English poets?
Why was the Tyndale-Coverdale translation important?
What is the greatest Anglo-Saxon poem?
Why did Swift write *Gulliver's Travels?* Why do we read it today?
Who were Joseph Addison and Sir Richard Steele?

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ENGLISH SETTER is a popular dog because of its handsome face and sleek coat. Its hunting skill also makes it a popular gun dog. The setter has a fairly long, flat coat, colored white, black, and tan, or in mixtures of white, black, lemon, orange, and chestnut. Long hairs called *feathers* cover its legs and tail. Many owners prefer setters that have a white coat with little flecks of color instead of coats with large, solid-colored patches.

The setter is quick and graceful in the field, and has a fine sense of smell. It shows the hunter where game is by making a point with its nose toward the game. Sometimes it lifts one of its front paws as it points. An English setter stands 24 or 25 inches high, and weighs from 50 to 70 pounds.

WILLIAM F. BROWN

See also DOG (color picture, Sporting Dogs).

ENGLISH SPARROW, also called *house sparrow*, is a dull-colored bird about six inches long. It has a reddish-brown coat, streaked with black, and grayish-white under parts.

Originally, English sparrows lived throughout Europe. In 1850, they were introduced into the United States, where they have become wild.

English sparrows do not migrate. They remain in the northern states throughout the winter. They eat any kind of food, and so they are able to survive in all kinds of weather and climates. These birds destroy grain, fruit, and many growing vegetables.

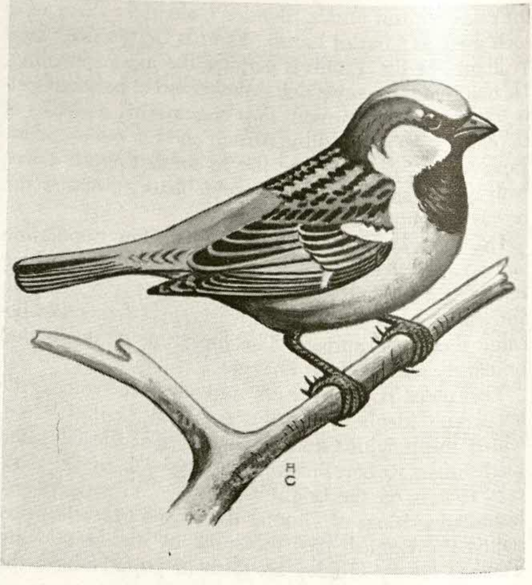
English sparrows quarrel constantly. They are noisy and untidy. Even their song, a shrill, insistent chirping, is unpleasant. They build their nests early, taking over nesting sites before other birds arrive. The female lays from four to nine eggs, which are usually white with yellowish-green, brown, or black spots. Three to four broods are reared each year.

Scientific Classification. The English sparrow belongs to the weaverbird family, *Ploceidae*. It is genus *Passer*, species *domesticus*.

GEORGE J. WALLACE

See also BIRD (color picture, Birds' Eggs [House Sparrow]); SPARROW; WEAVERBIRD.

The Male English Sparrow has a black throat and dust-colored feathers. The female has whitish throat feathers.



ENGLISH SPRINGER SPANIEL is a sporting dog that *springs* at game to drive it from its hiding place. Hunters use this dog more often than the cocker spaniel because it is larger, heavier, and stronger. A springer stands about 19 inches high, and weighs from 35 to 50 pounds. Its coat is not long, but grows thick enough to be resistant to water and brambles. English springer spaniels vary in color. They may be combinations of liver, black, tan, and white. See also DOG (color picture, Sporting Dogs). W. F. BROWN

ENGLISH TOY SPANIEL, a dog that came from China or Japan, was a favorite with English noblemen in the 1600's. It weighs from 9 to 12 pounds and has a round head, with a short, turned-up nose. The dog's wavy coat grows thickly, with a mane around its neck and long hairs called *feathers* on its feet. There are four kinds of English toy spaniels. The *King Charles* is black and tan. The *Prince Charles* is black, tan, and white. The *Blenheim* is red and white, and the *Ruby* English toy spaniel is all red. JOSEPHINE Z. RINE

Walter Chandoha

The English Toy Spaniel Has a Long, Silky Coat.

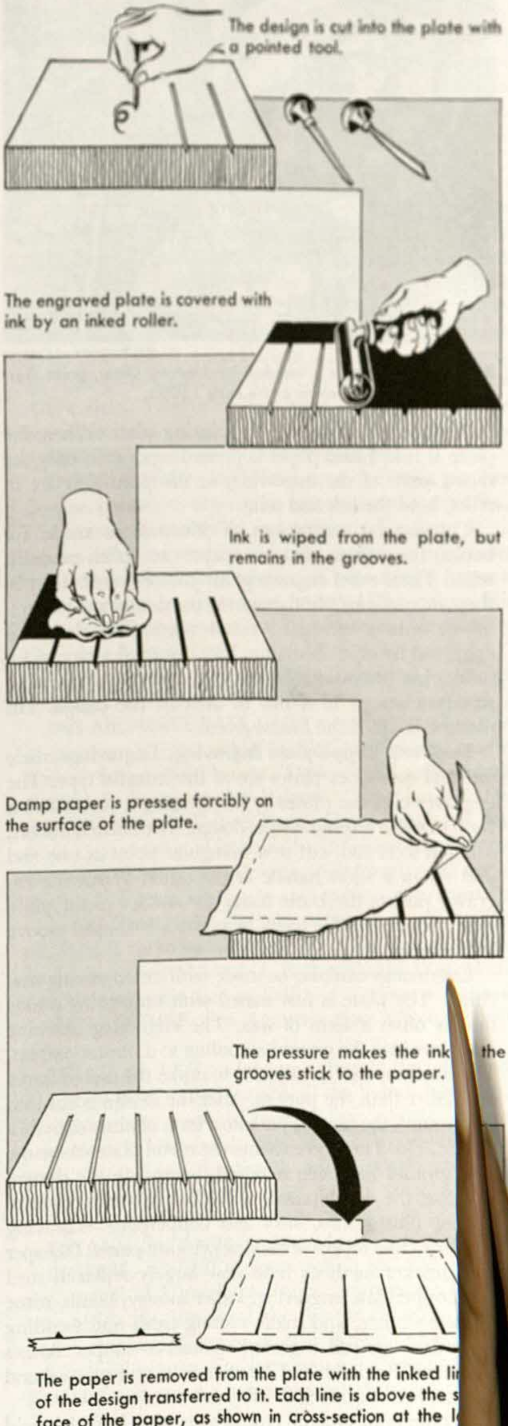
ENGRAVING is a method of carving a design or words on the surface of metal, stone, wood, or some other hard material. The word *engrave* comes from a French word meaning *to carve in*. The widest use of engraving has been in making plates from which to print. Prints made from engraved printing plates are also called engravings. Other uses of engraving include decorations on jewelry and silverware, and inscriptions such as the ones on stone monuments.

Making Prints from Engravings involves two methods, intaglio and relief. In *intaglio,* the designs or words are cut into a wood block or metal plate. The engraved lines are lower than the surface of the block or plate. After the engraving is completed, the whole surface of the printing block or plate is covered with printer's ink and then wiped off. The ink remains only in the carved lines of the letters or design. When paper is pressed against the surface of the plate, the ink is transferred to the paper. The pressure molds the paper into the grooved lines, and when the paper is removed, the ink stands in tiny ridges on the paper. In fine engraving work, every line of the print will appear slightly raised.

In *relief* engraving, the design stands higher than the

HOW AN ENGRAVING IS MADE

Intaglio, or below-the-surface, engraving is made by cutting a design or words into a wood block or metal plate. In the other type of engraving, called *relief engraving,* the design or words stands higher than the background surface on the printing plate.



The design is cut into the plate with a pointed tool.

The engraved plate is covered with ink by an inked roller.

Ink is wiped from the plate, but remains in the grooves.

Damp paper is pressed forcibly on the surface of the plate.

The pressure makes the ink the grooves stick to the paper.

The paper is removed from the plate with the inked li of the design transferred to it. Each line is above the s face of the paper, as shown in cross-section at the l

Art Institute of Chicago

Saint Christopher **is a woodcut by Albrecht Dürer, great German engraver and painter of the early 1500's.**

background surface on the printing plate. When the plate is inked and paper is pressed against it, only the raised parts of the engraving, or the parts that are in relief, hold the ink and print.

Commercial engravings of illustrations made for books, magazines, and newspapers are often made in relief. These relief engravings are *photoengraved*. That is, they are made by photographing the design and projecting it onto a sensitized metal plate. The design is engraved by acid. Benjamin Day invented a process for producing gradations in color or tone by applying a standard screen to a line or area in the design. His method is called the *Benday process*.

Steel and Copperplate Engraving. Engravings made on steel or copper plates are of the intaglio type. The engraver cuts the plates by hand, using a tool called a *burin* or *graver* to engrave the design. The burin is a short, squared steel rod, cut to a triangular point at one end and set in a short handle at the other. When the engraver pushes the burin along the surface of the plate with the palm of his hand, he plows a V-shaped groove in the metal plate.

Engravings can also be made with an engraving machine. The plate is first coated with an etching *ground* that is often a form of wax. The engraving machine cuts lines into the ground according to a master pattern. The machine can be adjusted to make the design larger or smaller than the pattern. After the design is cut into the ground, the plate is put into a bath of nitric or hydrofluoric acid. The acid eats into the metal plate where the wax ground has been removed, engraving the design.

Before the development of mechanical ways of reproducing illustrations, steel and copperplate engraving were the chief means of making printing plates. Cheaper and quicker methods have now largely replaced steel and copperplate engraving. Paper money, bonds, some postage stamps, and many visiting cards and wedding invitations are still engraved on steel or copper. Artists in France, England, and America have revived steel and copperplate engraving as a fine art.

Etching is an intaglio type of engraving in which acid cuts the lines in the plate to form a pattern (see ETCHING).

Wood Engraving. For commercial work, wood engravers carve designs on the end grain of a wooden block. The engraving may be done with a ruling machine or with hand tools. The design may be sketched on the block by hand or transferred to it by a photographic process. For commercial purposes, wood engraving is slow and costly compared with photoengraving. It is used to a certain extent where clean, sharp detail is needed.

The terms wood engraving and woodcut are often used to mean the same thing. But *woodcut* means a carved design made on a block of wood, cut on the flat grain of the plank. It is usually carved by hand by the artist himself, and is one of the oldest means of making reproductions of illustrations. Many artists still produce fine woodcuts (see WOODCUT).

Mezzotint is an intaglio type of engraving in which lights and shadows can be reproduced in tones midway between white and black. The word comes from an Italian word meaning *half tint*. A mezzotint engraving is made on a steel or copper plate which has been roughened into tiny peaks by a tool called a rocker. The peaks are scraped away to various depths to produce different shades of middle tones. The mezzotint method has largely been replaced by the halftone, rotogravure, and offset processes.

Dry-Point engraving is somewhat like steel or copperplate engraving. In dry point the lines are scratched on the plate with a fine etching needle instead of a burin. A soft ridge, or *burr*, is thrown up to one side of the line, and this burr forms the lines that appear on the print. Dry-point plates are printed in the same way as other intaglio engraved plates.

History. Men have engraved stone, metal, and other materials for thousands of years. The Sumerians, Egyp-

The Family **is an engraved reproduction of a painting by Antoine Watteau, painter of life and manners at the French court.**

Metropolitan Museum of Art

tians, Greeks, and Romans left many inscriptions carved in stone. The Chinese and Japanese decorated bronze, iron, copper, and precious metals with elaborate designs. Most experts agree that the earliest prints were made in Asia about A.D. 450 from wood blocks. In Europe, the earliest known print was made in 1423 from a wood block. By the 1600's, engraving was chiefly used to reproduce paintings, and painters often made their own engravings. Engraving in America began in the 1600's. S. W. Hayter

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Aquatint
Block Printing
Dürer, Albrecht
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Intaglio
Mantegna, Andrea
Photoengraving
Printing
Relief
Rotogravure
Schongauer, Martin
Woodcut

ENGRAVING AND PRINTING, BUREAU OF, designs, engraves, and prints paper money and securities for the United States government. It is a division of the Department of the Treasury in Washington, D.C. The bureau produces postage, internal revenue, customs, and savings stamps. It makes paper currency, bonds, notes, certificates, and Federal Reserve notes. It also produces paper checks, commissions, permits, and certificates of awards. An act of Congress on Aug. 15, 1876, provided for the first time that the bureau print all government notes and securities. A director supervises the work of the bureau. Bureau of Engraving and Printing

United Press Int.

Workers at the Bureau of Engraving and Printing print the United States government's paper money.

ENIAC. See Computer (History).

ENID, Okla. (pop. 38,859; alt. 1,250 ft.), the center of a wheat-growing district, is about 100 miles northwest of Oklahoma City (see Oklahoma [color map]). Enid has large flour mills, grain elevators, and oil refineries. It has the largest flour mill in the state, and the third largest wheat-storing area in the world. Only Minneapolis-St. Paul in Minnesota and Kansas City in Missouri and Kansas have larger wheat-storing areas. The city produces portable drilling equipment. It is the home of Phillips University and Vance Air Force Base.

Enid was incorporated in 1894. It serves as the seat of Garfield County, and has a council-manager form of government. John W. Morris

ENIWETOK, *eh NEE wuh tawk,* is a large, isolated atoll in the northwestern corner of the Marshall Islands. It consists of 40 low, sandy islets with a land area of 2¼ square miles. The lagoon in the atoll covers 388 square miles. See Atoll (picture).

After World War II, Eniwetok became a proving ground of the United States Atomic Energy Commission. In 1948, three improved atomic bombs were exploded there. The Commission set off four more explosions in 1951. The first hydrogen bomb was exploded at Eniwetok in 1952. Further hydrogen-bomb and other nuclear tests were conducted there by the United States in the late 1950's. Edwin H. Bryan, Jr.

ENLIGHTENED DESPOT. See Despotism.

ENLISTED MAN. See Rank in Armed Services.

ENOSIS. See Cyprus.

ENRIGHT, ELIZABETH (1909-), is an American author and illustrator. She won the Newbery medal in 1939 for her book *Thimble Summer,* a story of a summer on a Wisconsin farm. She wrote short stories for adults as well as books for children. Her works include *Saturdays* (1941), *Then There Were Five* (1944), and *Gone-Away Lake* (1957). Miss Enright was born in Chicago, Ill., and grew up in New York City. She studied at the Art Students' League in New York, and at the Parsons School in Paris. George E. Butler

ENSIGN. See Rank in Armed Services.

ENSOR, JAMES (1860-1949), was the only modern Belgian painter to acquire an international reputation. His paintings are morbid and satirical. The faces of his figures often resemble hideous masks, symbolizing spiritual decay. The pessimism of his subjects forms a weird contrast to the radiant beauty of his colors. His most important painting is a large canvas, *The Entry of Christ into Brussels.*

Ensor also executed many subtle and complex etchings. He was born in Ostend. Julius S. Held

ENT AIR FORCE BASE, Colo., serves as headquarters of commands responsible for the air defense of the United States and Canada. These commands include the North American Air Defense, Canadian Air Defense Command, United States Continental Air Defense Command and its subordinate units: Air Defense Command, Army Air Defense Command, and naval forces. The base lies inside the eastern city limits of Colorado Springs. An airdrome of the base, called *Peterson Field,* is six miles east of the city. The base is named for Major General Uzal G. Ent, a World War II air commander, who died in 1948. John H. Thompson

ENTABLATURE. See Architecture (Architectural Terms).

ENTAIL, *en TAIL,* is land or an estate that descends to certain heirs, rather than to all the heirs. Only direct descendants or a special class of descendants, such as *heirs male* or *heirs female,* may inherit the estate. The word comes from the French *tailler,* which means *to shorten* or *limit.*

See also Estate.

ENTASIS. See Architecture (Architectural Terms).

ENTEBBE, *en TEB uh* (pop. 7,932; alt. 3,789 ft.), is the capital of Uganda, a British protectorate in eastern Africa. It lies on Lake Victoria's north shore, and is connected by road with Kampala, Uganda's commercial center. For location, see Uganda (map). Entebbe's airport is a major stop on air routes between

Europe and South Africa. The city has no commercial importance. Many of the people are colonial administrators. Entebbe has government buildings, a hospital, and research institutes. It also has botanical gardens and a technical school. Hibberd V. B. Kline, Jr.

ENTENTE, LITTLE. See Little Entente.

ENTENTE, TRIPLE. See Triple Entente.

ENTERITIS, *EN ter I tis*, is an inflammation of the intestine. It may affect either the large or the small intestine, and may be mild or severe. Both men and animals suffer from enteritis. It has many causes, and often results from eating unsuitable or spoiled foods, or from exposure to cold. Diarrhea and painful cramps accompany severe enteritis. It also produces nausea, vomiting, and loss of appetite. The person usually shows signs of dehydration. The tongue and skin are dry and the temperature may be below normal. A patient with severe enteritis should be under a doctor's care. See also Colitis. Paul R. Cannon

ENTERPRISE. See Aircraft Carrier.

ENTERTAINMENT. See Amusements.

ENTOMOLOGY, *EN toh MAHL oh jih*, is a major branch of zoology that is concerned with the study of insects. Persons who specialize in this field are called *entomologists*. These scientists also study related animals such as spiders, mites, centipedes, and sowbugs, especially when these are destructive or are injurious to man's welfare. Aristotle wrote about insects more than 2,000 years ago, but the science of entomology is much younger. It grew out of studies of insect life histories and anatomy published during the 1600's and 1700's. The science developed rapidly when the Swedish naturalist Carolus Linnaeus provided a useful method of classifying plants and animals (see Linnaeus, Carolus; Insect [Classifying the Insects]).

What Entomologists Study. Entomologists study the embryology and development, anatomy and physiology, life history and habits, ecology, and classification of each insect.

Insects are among man's chief competitors. For example, between 1925 and 1958, grasshoppers destroyed $800,000,000 worth of agricultural crops and $2,000,000,000 worth of range grass. Each year insects cause a loss of about $250,000,000 to cotton growers in the United States. Therefore, entomologists devote much study to insects that affect plants or animals important to man. Most professional entomologists are engaged in some branch of *economic*, or *applied*, entomology. They seek not only to control the numbers of insects, but to increase those that are beneficial and to decrease those that are harmful to man's welfare. *Agricultural* entomologists study insects that affect the production of foods and fibers. *Forest* entomologists study those that affect woods. *Medical* and *veterinary* entomologists are concerned with insects that in any way influence the health of man and of animals. It is largely through the efforts of these scientists that insecticides have been developed to protect crops and to reduce the incidence of insect-borne diseases.

Some insects are beneficial to man. Silkworms contribute a valuable fiber. Honey bees not only provide a food, but help to pollinate plants. Other insects are helpful to man, but their helpfulness is sometimes not recognized. These are the insects that prey upon others, and in so doing destroy those that might be harmful. Entomologists seek ways to protect desirable insects.

Careers in Entomology. Students who wish to pursue entomology as a career must have at least a bachelor's degree in entomology or zoology. Most teaching and research positions require a master's degree or doctor's degree. Entomologists are employed by state and federal experiment stations, and agricultural and public health agencies. They may also work for universities or museums. Some work in industry, particularly the making of insecticides. E. Gorton Linsley

See also Insect; Insecticide.

ENTRECHAT. See Ballet (Terms); Dancing (Ballet).

ENTREPRENEUR. See Industrial Revolution (Before the Revolution); Industry (Management).

ENTROPY, *EN troh pih*, is a concept in *thermodynamics*, the branch of physics that deals with heat as a form of energy. One way of stating the second law of thermodynamics is that mechanical energy can be converted completely into heat, but heat cannot be converted completely into mechanical energy. Entropy is related to this unavailability of heat energy. It is a sort of thermodynamic degeneration which either increases or remains constant for every physical process in an isolated system. Clarence E. Bennett

ENUNCIATION. See Pronunciation.

ENVELOPE, *EN veh lohp*, or *AHN veh lohp*, is a piece of folded, sealed paper. It serves as a wrapper to hold letters and other papers to be mailed, or acts as protection against loss or damage. Envelopes are made of a single sheet of paper folded so that one flap remains open. This flap is gummed so that the envelope may be sealed after the letter or papers have been inserted. Self-sealing envelopes make use of a gum that need not be moistened to stick.

Envelopes were first manufactured in 1839 by a New York City man named Pierson. Before that time, all letters were folded so that a blank portion of the paper could be used for the address. The edges of the paper were sealed with sealing wax. For about 10 years after envelopes were invented, they were cut, folded, and pasted by hand. A worker could make about 3,000 envelopes a day. The first successful machine for making envelopes was patented in 1849 by J. K. Park and C. S. Watsen of New York City. A greatly improved envelope machine was patented in 1898 by John Ames Sherman. It lowered the cost of making gummed envelopes from 60 cents a thousand to 8 cents a thousand. The "window envelope," which has a transparent section through which the name and address of the addressee can be seen on the enclosed letter, was patented by Thomas Callahan in 1902, and manufactured in Springfield, Mass. This type of envelope became a great timesaver to businesses that send out many letters, such as bills to customers. The name and address need not be written on the envelope. Today, some envelope-making machines can turn out over 250,000 envelopes a day.

Envelopes are numbered from 5 to 14 according to size. A No. 5 envelope is $5\frac{1}{2}$ inches long and $3\frac{1}{16}$ inches wide. A No. $6\frac{1}{4}$ envelope is 6 inches long and $3\frac{1}{2}$ inches wide. A No. $6\frac{3}{4}$ is $6\frac{1}{2}$ inches long and $3\frac{5}{8}$ inches wide. No. 10, most often used for business letters, is $9\frac{1}{2}$ inches long and $4\frac{1}{8}$ inches wide. Edith Lillian Smith Webster

See also Post Office (Stamped Envelopes).

ENVIRONMENT, *en VIE run munt.* Many factors influence man and other living things. Some are internal and are inherited. Others are external. A combination of these internal and external factors makes up environment. All parts of a man's environment interact with his inherited characteristics to make him what he is. Both heredity and environment are essential for the existence of man, and of all other living things.

Physical, chemical, biological, and cultural factors make up man's external environment. In addition, his body possesses mechanisms that control various elements of his internal environment. These elements include temperature, water content, chemical composition, hormone balance, and disease-producing parasites.

Physical and Chemical Environment. The physical and chemical factors in man's external environment include temperature, atmospheric gases, water, poisonous substances, and various kinds of radiation. The earth receives radiant heat from the sun. Without it no life could exist. Visible light affects all forms of life. With too little light, plants could not make food. Many plants and animals are delicately adjusted to the amount of light they must obtain each day. This often accounts for their seasonal behavior.

Ultraviolet radiation from the sun is necessary for the formation of vitamin D in man's body. But too much produces severe sunburn. To counteract this, man has dark pigments, called *melanin,* in his hair, skin, and eyes. Melanin filters out some of the ultraviolet rays. Radiations of shorter wave lengths, such as gamma rays, injure the molecules that transmit hereditary characteristics. The same is true of high-speed nuclear particles found in cosmic rays.

Biological and Cultural Environment. Man's biological environment is equally important to his survival and well-being. For example, green plants make his food. Parasites may infest or infect his body. But some microorganisms are essential to maintain his environment. They cause organic material to decay and restore chemical components for new generations.

A most important part of man's biological environment is his social or cultural environment. Man's highly developed nervous system has made possible memory, reason, and communication. Humans teach their children and their fellow men what they have learned. This process of transmission of accumulated knowledge is responsible for man's uniqueness in possessing religion, art, music, literature, technology, and science.

Man's cultural and biological inheritance has enabled him to go far beyond any animal in controlling his environment. Animals build environment-controlling nests or houses. But man has conquered the tropics and the polar regions, the ocean and the upper atmosphere. He has brought under control many parasites that cause disease. He is exploring outer space to learn how to control that environment as well. G. W. BEADLE

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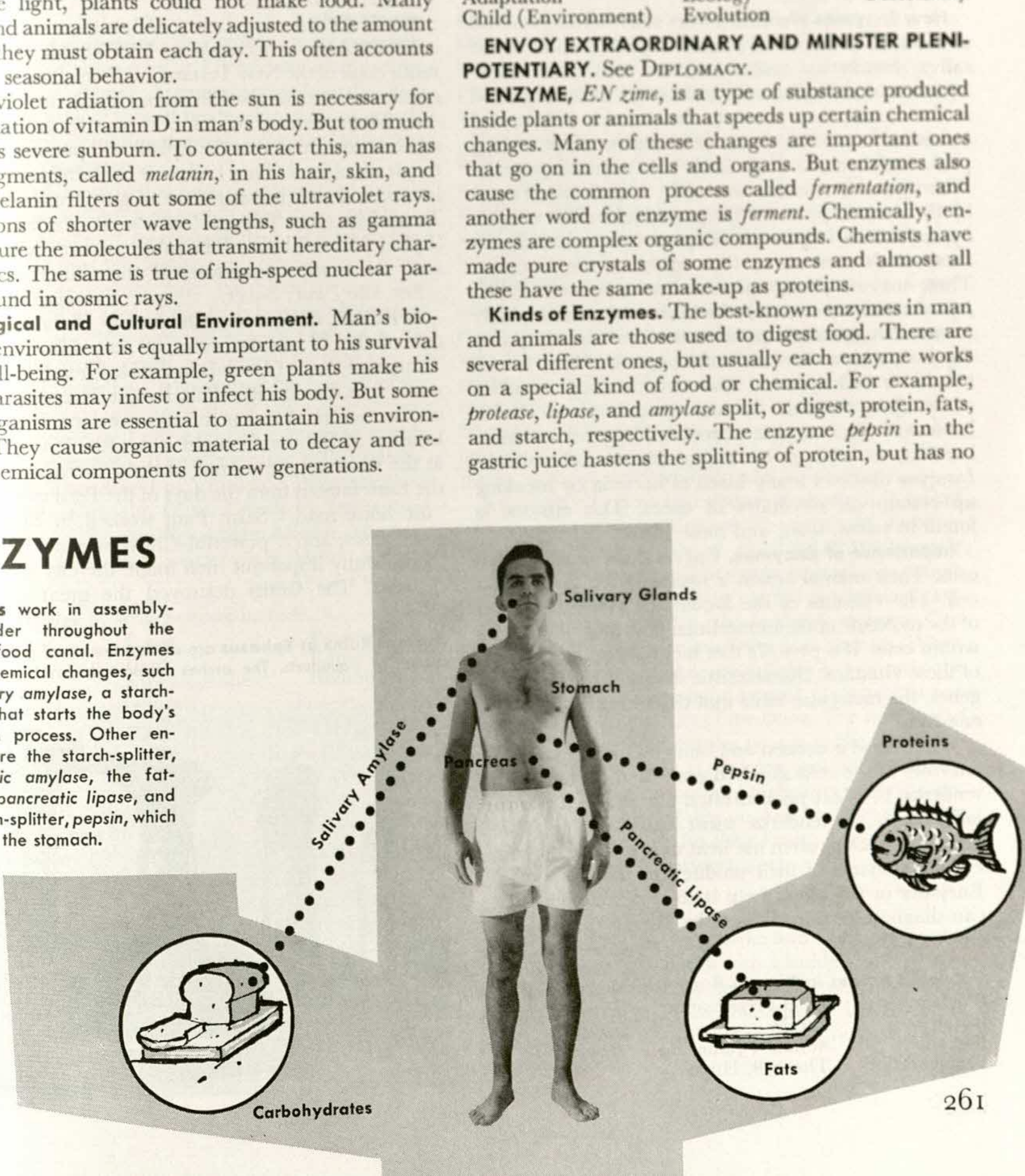
Adaptation
Child (Environment)
Climate
Ecology
Evolution
Heredity
Personality

ENVOY EXTRAORDINARY AND MINISTER PLENIPOTENTIARY. See DIPLOMACY.

ENZYME, *EN zime,* is a type of substance produced inside plants or animals that speeds up certain chemical changes. Many of these changes are important ones that go on in the cells and organs. But enzymes also cause the common process called *fermentation,* and another word for enzyme is *ferment.* Chemically, enzymes are complex organic compounds. Chemists have made pure crystals of some enzymes and almost all these have the same make-up as proteins.

Kinds of Enzymes. The best-known enzymes in man and animals are those used to digest food. There are several different ones, but usually each enzyme works on a special kind of food or chemical. For example, *protease*, *lipase*, and *amylase* split, or digest, protein, fats, and starch, respectively. The enzyme *pepsin* in the gastric juice hastens the splitting of protein, but has no

ENZYMES



Enzymes work in assembly-line order throughout the body's food canal. Enzymes cause chemical changes, such as *salivary amylase*, a starch-splitter that starts the body's digestion process. Other enzymes are the starch-splitter, *pancreatic amylase*, the fat-splitter, *pancreatic lipase*, and a protein-splitter, *pepsin*, which works in the stomach.

effect on the digestion of fat, starch, or sugar. The enzyme *invertase* helps digest cane sugar but not malt sugar or milk sugar. Almost every enzyme has a special kind of medium, or surrounding, in which it works best. Scientists say it is sensitive to its medium. Some enzymes work best if the medium is slightly alkaline, others if it is slightly acid. The *pepsin* of the gastric juice is an enzyme that acts normally on the stomach contents when they are acid.

Not all enzymes merely digest compounds, or break them up. Some help build new compounds out of simpler ones. This action is called *synthesis*. Enzymes help plants synthesize starches and fats from carbon dioxide and water, and proteins from carbon dioxide, water, nitrogen, and sulfur. They help man and animals build and repair body tissues and produce energy for work and body heat from foods eaten. Enzymes are destroyed by heat, and many are destroyed when they are exposed to light.

How Enzymes Work. Enzymes start working on food as soon as it enters the mouth. *Ptyalin*, a part of the saliva, breaks up cooked starches and other carbohydrates into dextrins and maltose. It mixes with food in the mouth, then passes to the stomach with it, and continues its action there. Lean meat, white of egg, peas, and beans are all foods that contain proteins. When proteins reach the stomach, they are acted upon by the enzyme pepsin of the gastric juice. The enzyme *trypsin*, which is part of the pancreatic juice, digests these foods even more thoroughly in the intestine. These enzymes change proteins into compounds called *peptones* and *amino acids*, which are easier for the body to use. Druggists sell proteins that are already partly digested, such as beef and milk peptones. They are for infants or sick persons who cannot digest proteins easily. *Zymase* changes the sugar glucose into alcohol or lactic acid. This enzyme is produced by yeast and some bacteria, as well as by higher plants and animals. *Lysozyme* dissolves many kinds of bacteria by breaking up certain carbohydrates in them. This enzyme is found in saliva, tears, and most animal fluids.

Importance of Enzymes. Enzymes are present in all cells. Their normal action is necessary for the life of a cell. The vitamins of the B-complex group form part of the molecule of the intracellular enzymes, or enzymes within cells. If a person's diet lacks adequate amounts of these vitamins, characteristic diseases develop. Even genes, the molecular units that determine heredity, are enzymes.

When meat is dressed and hung in a refrigerator, the enzymes of the cells slowly digest the meat and partly tenderize it. Meat packers often use enzymes, particularly pepsin, to tenderize meat artificially. Fruit and vegetable packers often use heat to inactivate the intracellular enzymes of their products to prevent spoiling. Enzymes in the blood help it to clot, and physicians can diagnose certain diseases by testing the blood for enzymes.

ANDREW CONWAY IVY

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Digestion
Fermentation
Food Preservation
Pepsin
Sumner, James B.
Theorell, Hugo
Trace Elements
Trypsin
Yeast

EOCENE EPOCH. See GEOLOGY (table, Outline of Earth History).

EOHIPPUS. See HORSE (Early Horses; picture, Ancestors of the Horse); EVOLUTION (picture, Evolution of Animals with Backbones).

EOLITHIC PERIOD. See PREHISTORIC MAN.

EPAMINONDAS. See PELOPIDAS; THEBES.

ÉPÉE. See FENCING.

EPHEBIC OATH. See ATHENS (The Ephebi).

EPHEDRINE, *eh FED rihn*, is a drug used to treat asthma. It comes from the roots of the Chinese plant *Ephedra*. Ephedrine acts on the body much like adrenalin (epinephrine). It increases blood pressure and the beat of the heart, and dilates the pupils of the eyes. It also shrinks mucous membranes, and sometimes is used to clear stuffy sinus and nasal passages.

Unlike adrenalin, ephedrine can be taken by mouth. It proves especially valuable in relieving the choking spasms in asthma. Ephedrine has also been used to relieve hay fever.

AUSTIN EDWARD SMITH

See also ADRENALIN.

EPHEMERIDA. See INSECT (Classifying the Insects).

EPHESIANS, *ee FEE zhunz*, **EPISTLE TO THE,** is the tenth book of the New Testament. Saint Paul wrote this epistle, or letter to the Christian church, at Ephesus in Asia Minor, during the time he was in prison. Many scholars now think that the Epistle was put together after the death of Paul. They believe it contains parts of other letters, and that it was meant to go to other churches. Two of its great passages refer to Paul's best prayers (Eph. 1:15-23; 3:14-21). The subject matter deals mainly with the *unity*, or oneness, of the church of Christ.

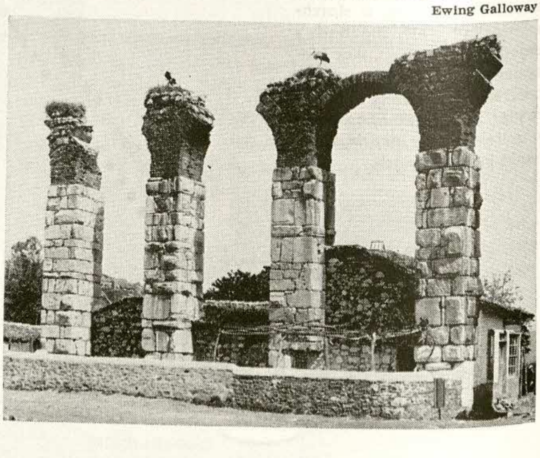
See also PAUL, SAINT.

FREDERICK C. GRANT

EPHESUS, *EHF ee sus*, was the city of the Ephesians, one of the 12 ancient cities of Asia Minor. A great Temple of Diana (Artemis in Greek legend) at Ephesus made it a sacred city. This temple is considered one of the Seven Wonders of the Ancient World. The location of Ephesus brought it wealth. It was situated at the starting point of one of the great trade routes of the East, famous from the days of the Persian Empire as "the horse road." Saint Paul worked in Ephesus for three years, and a powerful Christian church grew up there. Many important men made the city their headquarters. The Goths destroyed the great temple of

Ancient Ruins at Ephesus are all that remain of a once-great system of aqueducts. The arches supported clay water pipes.

Ewing Galloway



Ephesus in A.D. 262. The city became less and less important, and had almost disappeared by the late 1300's. The site of Ephesus is near the mouth of the Kucuk Menderes River in present-day Turkey. See Ephesians, Epistle to the. Frederick C. Grant

EPHIALTES, a Greek traitor. See Thermopylae.

EPHIALTES, a Greek statesman and general. See Pericles.

EPHOD. See High Priest.

EPHRAIM, son of Joseph. See Joseph (Settling His Family in Egypt).

EPHRAIM. See Wisconsin (Interesting Places to Visit).

EPHRATA, *EHF ruh tuh,* Pa. (pop. 7,688; alt. 380 ft.), is a marketing center in Lancaster County (see Pennsylvania [map]). Ephrata was the site of the Cloister, a religious community. Conrad Beissel and the Seventh-Day German Baptists established the Cloister in 1732. It became a music and printing center. One of the earliest printing presses in the United States began operation there. Its buildings are preserved by the state. Ephrata has a council-manager form of government. S. K. Stevens

EPIC, *EP ick,* is a poem that tells a story, especially a story of heroic characters and deeds, mythical beings, and miraculous events. A true epic needs a dignified subject. This subject should be developed in an orderly manner without emotional stress, except in the statements of the characters.

Epics which are based on heroic legends are usually called *folk* epics. The two great Greek epic poems by Homer, the *Iliad* and the *Odyssey,* belong to this class. Others include the Old English epic, *Beowulf,* the French epic *Chanson de Roland,* and the German epic, the *Nibelungenlied.* The epic of the Irish hero, *Cuchulainn,* is another example. The national epic of Finland is the *Kalevala.* This work served as a model for *The Song of Hiawatha* by Longfellow, who shaped the legends of the Algonkian Indians into an artificial folk epic.

Epics sometimes tell of imaginary events not principally based on legends. These are often called *literary,* or *art,* epics. The *Aeneid* of Virgil is a masterpiece of this type. Others are the *Divine Comedy* by Dante, and *Paradise Lost* and *Paradise Regained* by Milton. The only epic comparable to those written since Milton is *Faust* by Goethe. George Frisbie Whicher

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EPICTETUS, *EP ik TEE tus* (A.D. 60?-117?), was a Greek Stoic philosopher. He taught that we should not demand that events happen as we want. We should instead want them to happen as they do. A wise, divine Providence governs all things, so that what seem to be calamities are really parts of a divine plan that orders everything for the best. He thought only foolish men are upset by events they cannot control. The true Stoic can face even death and all so-called misfortunes with perfect calm (see Stoic).

Epictetus was born in Asia Minor, and was a slave in his youth. He became free, and lived and taught in Rome until A.D. 89, when the Emperor Domitian expelled the philosophers. Epictetus spent the rest of his life teaching in Nicopolis, Greece. Lewis M. Hammond

EPICURUS, *EP ih KYU rus* (342?-270 B.C.), a Greek philosopher, founded a system of philosophy called *Epicureanism.* He started out from the principle that the good is pleasure and that pain is evil. But he saw that an uncontrolled pursuit of pleasure involved more pain than good in life. So he taught that the wise man cut down his desires; the wise man lived a simple, temperate life, and thereby avoided the pain and evil that plague so many people.

Epicurus thought that pain, fear of death, and fear of the gods were the greatest threats to man's happiness. He taught that a temperate life reduced pain. Epicurus used Democritus' atomic philosophy to eliminate fear. He believed that if the world and everything in it, including man, were just chance combinations of atoms, then we only feel pain and fear so long as we live. But when we die, the atoms disperse, and we cannot suffer any feelings of evil or fear. He explained the gods as merely combinations of atoms, with no power to rule or punish men. Epicurus held that if lightning strikes a man, that is a natural accident and not Zeus (the Greek king of the gods) hurling a thunderbolt to punish him. Such fears should not disturb a person's tranquillity.

Epicurus was born on the island of Samos. He established a school of philosophy in Athens in about 306 B.C., and attracted many pupils to it. He and his students lived frugally, enjoyed conversation, and sought peace of mind. After Epicurus' death, his philosophy spread to Rome. Lewis M. Hammond

EPIDEMIC, *EHP uh DEM ik,* is an outbreak of disease which attacks many people at about the same time. An epidemic may spread through one or several communities. When a disease exists permanently in a region, it is said to be *endemic.* When it spreads over the world, it is *pandemic.* Diseases that are truly epidemic are caused by germs which pass from one person to another. Examples of such diseases are measles, smallpox, diphtheria, malaria, typhoid fever, and influenza.

Knowing the cause of a disease and how it is spread aids in preventing epidemics. For example, bubonic plague caused the deaths of about 60,000,000 people during the Middle Ages. Then men learned that people caught the disease from fleas carried by infected rats. When the rats were killed, the epidemic stopped. Certain mosquitoes carry yellow fever and malaria. Wherever the breeding of the mosquitoes is stopped, the diseases disappear. The fight against epidemics is one of the most exciting stories of medicine. The methods of fighting them are to immunize people to the disease, to treat them if they catch it, to keep their environments clean so germs cannot breed, to enforce quarantines, preventing the spread of disease, and to educate people to be clean and to care for their health. Thomas Parran

See also Disease, Communicable.

EPIDERMIS. See Skin.

EPIGLOTTIS. See Throat.

EPIGRAM, *EHP uh gram,* as the term is properly used, is a short poem which closes with a sudden surprising or witty turn. These poems are usually not more than eight lines in length. An anonymous Latin author described the epigram while at the same time producing a very clever one:

The qualities rare in a bee that we meet,
In an epigram never should fail—
The body should always be little and sweet,
And a sting should be left in its tail!

The term *epigram* just as often means any concisely or cleverly expressed thought. It may be in either verse or prose, and does not necessarily require a "sting in its tail." The poet Martial wrote typical ones:

"Lycoris has buried all the female friends she had; would she were the friend of my wife!"

"Nothing is more confident than a bad poet."

The Greeks invented the epigram. With them it was a simple and beautiful verse written for a tomb or statue. Thus the word had at one time the same practical meaning as *epitaph*. Martial and Catullus, two Latin satirical poets, first produced the sharp, stinging epigram known today. Among the English, one of the cleverest epigram writers was Alexander Pope. Some of his poems are merely strings of epigrams. He wrote:

Why has not man a microscopic eye?
For this plain reason—Man is not a fly.

He also wrote:

But thousands die without or this or that—
Die, and endow a college or a cat.

Sir John Harrington, another English writer, wrote:

You beat your pate, and fancy wit will come:
Knock as you please, there's nobody at home.

A quick and clever exchange of epigrams took place once between Charles II of England and one of his courtiers, who said these lines:

Here lies our sovereign lord, the king,
Whose word no man relies on,
Who never said a foolish thing,
And never did a wise one.

Charles replied, "True, my words are my own; my actions are my ministers'."

In a wider sense, many proverbs can be considered epigrams. An example is Shakespeare's "All that glisters is not gold."

EPIGRAPHY. See PALEOGRAPHY.

EPILEPSY, *EHP ah LEHP sih*, is a disease of the nervous system. It may be inherited, but it cannot be communicated from one person to another. There are three types of epilepsy. The most severe form is called *grand mal*. A less severe type is called *petit mal*. A third form causes a patient to behave in an automatic manner, without knowing what he is doing. Sometimes a person has more than one type of epilepsy.

In a severe attack of epilepsy, the patient loses consciousness suddenly and may fall. His muscles contract in spasms, or convulsions. This attack may last 2 to 5 minutes and is followed by a period of complete relaxation or stupor. A patient who suffers from mild epilepsy may have a brief period of unconsciousness, or certain abnormal sensations or emotional disturbances. These attacks are most common in childhood.

The exact cause of epilepsy is not known. But doctors have been able to study the disease by means of the *electroencephalograph*, an instrument especially designed for this purpose. This instrument records the electric waves given off by the tissues of the brain. There are characteristic changes in the wave forms from the brain of a patient who has epilepsy. When he suffers an attack, violent changes occur, because his brain has suddenly released a burst of energy.

An important function of the brain is to change energy derived from the sugar and oxygen in the blood into nervous energy. An epileptic attack results from the failure of the brain to limit and control the time and place of its release of this nervous energy. The period of relaxation which follows an attack indicates that all the brain's available stores of energy have been exhausted.

Sometimes the disturbance is in only one portion of the brain. The patient then will have certain symptoms, depending on the function of that part of the brain. For example, if the part of the brain that controls movements of the leg is affected, the leg will jerk.

Epileptic seizures may be produced by anything that injures the brain, such as a blow on the head, or interference with the supply of blood or oxygen to the brain. Poisonous substances can also produce epileptic disorders. Epilepsy may be treated by the use of drugs which control or prevent the attacks. In some cases, brain surgery is effective. Patients are encouraged to live as normal lives as possible. FREDERIC A. GIBBS

EPILOGUE, *EHP uh lawg*, is a term that comes from two Greek words meaning *upon*, or *after*, *a speech*. In oratory, an epilogue sums up or concludes a speech. Plays once started with a *prologue*, or introduction, and ended with an epilogue. The epilogue was a short speech in verse or prose. It was intended to emphasize the moral of the play. In a novel, it adds events that happened after the end of the story. GLENN HUGHES

EPIMENIDES, *EHP ih MEN ih deez*, was a Cretan priest and poet who lived during the 500's B.C. He has sometimes been called one of the Seven Wise Men of Greece. There is a legend that he slept for 57 years, and during this time received the divine inspiration that determined his future. Epimenides is said to have lived for 299 years, and to have been the prophet quoted by Saint Paul in Titus 1:12. C. BRADFORD WELLES

See also SEVEN WISE MEN OF GREECE.

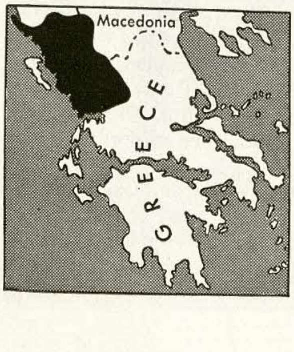
EPIMETHEUS. See PROMETHEUS.

EPINEPHRINE. See ADRENALIN.

EPIPHANY, *ee PIHF uh nih*, or **LITTLE CHRISTMAS,** is a holy festival observed on January 6 in the Roman Catholic, Anglican, and Eastern churches. Originally it celebrated both the birth and the baptism of Jesus. Since the fourth century, the day has honored especially the meeting of the Three Wise Men, or Magi, with the infant Jesus. In some countries, doorways are marked with the initials of the Magi to keep evil away. See also TWELFTH NIGHT. ALBERT E. AVEY and FULTON J. SHEEN

EPIPHYTE. See AIR PLANT.

Location Map of Epirus



EPIRUS, *ee PY rus*, is a region in northern Greece and southern Albania. It once formed an important kingdom of the ancient world. The land is a series of high ridges and narrow, fertile valleys. The people have always been cattle raisers. Several Illyrian tribes inhabited ancient Epirus. One of the ruling families, the

Molossians, gained control over the whole region in the 300's B.C. The Molossians claimed to be descended from Achilles. The most noted of the Molossian rulers, Pyrrhus (318?-272 B.C.), won several victories over the Romans. Epirus surrendered to the Romans in 167 B.C. and later became part of the Byzantine Empire. Today, northern Epirus belongs to Albania, and the rest to Greece. See also PYRRHUS. C. BRADFORD WELLES

EPISCOPALIANS, *ee PIHS koh PAY lih unz,* belong to an American religious organization officially known as the PROTESTANT EPISCOPAL CHURCH IN THE UNITED STATES OF AMERICA. It is the self-governing American branch of the Anglican Communion.

Doctrine. Episcopalians accept the Bible as the divinely inspired word of God. They believe in the Trinity, the Virgin Birth, and the Incarnation. They accept the Apostles' Creed and the Nicene Creed. Baptism and Communion are considered sacraments. Confirmation, penance, ordination, matrimony, and unction are considered sacramentals. The *Book of Common Prayer* contains the services and prayers of the Episcopal Church. It is outstanding in the literature of religious worship for the beauty of its English prose style. Some Episcopal parishes are called *high church,* because of their elaborate ceremonies. Others, called *low church,* advocate a less involved ritual. *Broad churchmen* stress the importance of a rational understanding of Christian tradition and a concern for liberal values.

History. The Episcopal Church, established in 1607, was the first church founded in the newly formed American colonies. At first it had little following, and the Revolutionary War caused serious setbacks. But in 1789 the church became independent from the Church of England, with its own bishops and constitution. The constitution provided for a General Convention, which meets every three years, made up of a House of Bishops and a House of Clerical and Lay Deputies. A period of rapid growth began after 1830, and the General Convention of 1835 adopted an active missionary policy. During the Civil War, the Southern dioceses formed a separate organization, but reunited with the Northern group in 1865. In 1919, the General Convention set up the National Council as the executive agency of the church in missionary work, education, and social service.

The church initiated the Chicago-Lambeth Quadrilateral in 1888, which contained the following four points as a basis for unity among all Christian churches: (1) the Holy Scriptures as the Word of God, (2) the Apostles' and Nicene Creeds as the rule of faith, (3) the two sacraments of Baptism and Holy Communion, and (4) the episcopate as the central principle of church government. It organized the first World Conference on Faith and Order at Lausanne, Switzerland, in 1927. For membership of the Protestant Episcopal Church in the United States, see RELIGION (table). WALTER H. STOWE

See also CHURCH OF ENGLAND.

EPISTLE, *ee PIHS'l,* originally referred to any letter, especially a formal or thoughtful letter. Later, it came to mean a piece of writing meant only for publication. The many epistles of Cicero shed much light on ancient Rome. The Epistles of St. Paul in the New Testament encouraged and instructed the early Christians. *Epistolae Obscurorum Virorum (Letters of Obscure Men)* is a collection of anonymous letters that attacked the clergy during the Reformation in the 1500's.

The *verse epistle* is a minor type of poetry. Horace wrote epistles in verse form; for example, his *Ars Poetica* (Art of Poetry). Ovid also wrote epistles, imaginary love letters from celebrated heroines. Alexander Pope's *The Epistle to Dr. Arbuthnot* is an outstanding example of neoclassical verse epistles. CHARLES W. COOPER

EPITAPH, *EHP uh taf,* is a memorial inscription on a tombstone or other monument to the dead. The term comes from two Greek words *epi* (upon) and *taphos* (tomb). The word also means a literary memorial composed in honor of the dead, but not intended to be inscribed on a monument. The earliest known epitaphs are those found on Egyptian coffins. The Greeks excelled as composers of epitaphs. Many curious epitaphs are found in old English churchyards and in New England. Benjamin Franklin wrote this epitaph:

The body of
Benjamin Franklin, Printer,
Like the cover of an old book,
Its contents worn out,
And stript of its lettering and gilding,
Lies here food for the worms.
Yet the work itself shall not be lost,
For it shall, as he believes,
appear once more,
in a new
and more beautiful edition
Corrected and amended
By the Author.

Robert Louis Stevenson wrote this epitaph:

Under the wide and starry sky
Dig the grave and let me lie.
Glad did I live and gladly die,
And I laid me down with a will.
This be the verse you grave for me:
"Here he lies where he longed to be;
Home is the sailor, home from the sea,
And the hunter home from the hill."

The modern custom is to inscribe epitaphs that usually consist only of the name, dates of birth and death, and perhaps a few words of commemoration. J. N. HOOK

See also SHAKESPEARE, WILLIAM (picture, These Lines).

EPITHELIOMA, *EHP ih THEE lih OH muh,* is any tumor of the *epithelium,* the tissue that lines the body cavities and covers the body surface and the internal organs. These tumors may be either benign or malignant. However, most doctors use epithelioma to denote common cancers of the skin. The epithelioma often begins as a small sore that will not heal. But sometimes it will seem to heal over, and then reappear. These tumors may be caused by prolonged exposure to the sun, X rays, or by materials containing tars or arsenic. Unlike most cancers, malignant epitheliomas usually do not spread to other parts of the body. They can be cured readily by surgery or X rays. C. P. RHOADS

EPITHELIUM, *EP ih THE lih um,* is one of the major kinds of tissue formed in the bodies of human beings and some animals. It covers the body surface and lines the channels of the body that have openings to the outside. For example, the respiratory tract, alimentary tract, and the urinary tract are lined with epithelium.

Three types of cells make up the epithelium. They are the squamous, cuboidal, and columnar cells. These cells are differentiated by their shape. The *squamous cells* are thin and scalelike. They have irregular edges. These cells make up the tissue that covers the body surface and lines the mouth and esophagus. *Cuboidal cells* look like tiny cubes. They are almost as tall as they are broad. These cells line some of the body cavities and are found in many of the glands. *Columnar cells* resemble columns. They are much taller than they are broad. Tissue made up of these cells lines the stomach and intestines. A form of columnar epithelium lines the respiratory passages. W. B. YOUMANS

See also EPITHELIOMA.

EPOCH, *EHP uhk,* or **ERA,** is a period of time, and the grouping of various great events in the history of the world occurring within that period. Some important eras and their approximate beginning dates are:

Grecian Era	5598 B.C.	The Greek calendar fixed this date for the Creation.
Jewish Era	3761 B.C.	The Jewish calendar fixed this date for the Creation.
Chou Era	1027 B.C.	The Chou dynasty established the classical period in China.
Olympiads	776 B.C.	The Greeks held their first Olympic Games.
Roman Era	753 B.C.	The Romans fixed this date for the founding of Rome.
Seleucidan Era	312 B.C.	Seleucus I founded the Seleucid dynasty.
Maccabean Era	166 B.C.	Judas Maccabaeus led the Jews in a revolt against the Syrians.
Vikrama Era	58 B.C.	India's legendary King Vikramaditya drove the Sikas from Ujjayini.
Christian Era	A.D. 1	Christians fixed this date as the year of Christ's birth.
Era of Diocletian	A.D. 284	The Roman Army proclaimed Diocletian emperor.
Islamic Era	A.D. 622	Mohammed fled from Mecca to Medina.

See also AGE; CALENDAR; CHRISTIAN ERA; GEOLOGY (table, Outline of Earth History).

EPSOM SALT is a white crystalline powder of magnesium sulfate widely used as a laxative. It is named for the springs at Epsom, England, where it was originally obtained. Epsom salt acts by preventing the intestine from absorbing water. As the water accumulates, the intestine discharges its contents.

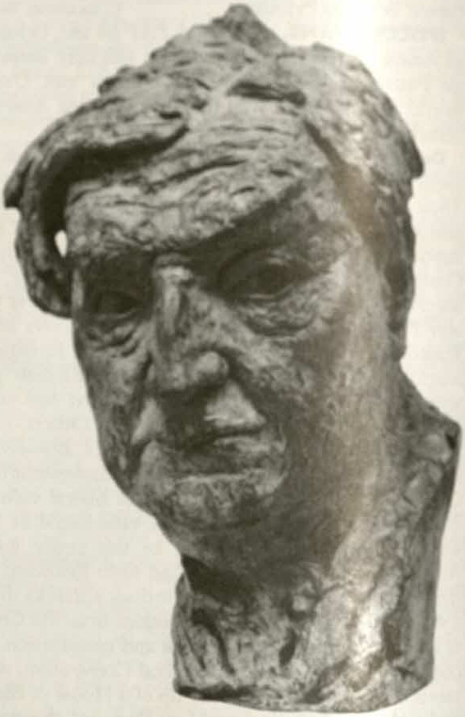
America now obtains Epsom salt in large quantities as a by-product of the manufacture of carbon dioxide for soda water. Much of the supply in Europe comes from the Stassfurt salt beds in Saxony, Germany.

Epsom salt should not be used frequently, because it delays the absorption of other substances, including important foods, as well as water. It should never be taken when there is any abdominal pain. AUSTIN EDWARD SMITH

See also CONSTIPATION; MAGNESIUM; SALTS.

EPSTEIN, *EP stine,* **SIR JACOB** (1880-1959), was a British sculptor who carved directly in hard stone, as sculptors did in the Middle Ages.

Many critics bitterly attacked his large statues because of the way he showed the human figure. But Epstein created portrait busts of many famous persons that won wide acceptance. He used a rough finish to create lights and shadows in the faces, giving an almost fleshlike appearance to the busts. His monumental *Social Consciousness* stands in Fairmount Park in Philadelphia, Pa. His statue, *Lucifer*, stands in the Birmingham Art Gallery in England.



United Press Int.; City Museum and Art Gallery, Birmingham

Jacob Epstein, *left,* **was a widely known British sculptor. His portrait bust of the modern British composer, Ralph Vaughan Williams,** *above,* **stands in the Birmingham (England) Art Gallery.**

Epstein was born in New York City. He became a British subject in 1910. Queen Elizabeth II knighted him in 1954. WILLIAM MACDONALD

EPWORTH LEAGUE. See METHODIST YOUTH FELLOWSHIP.

EQUALITY STATE. See WYOMING.

EQUATION. See ALGEBRA; CHEMISTRY (Chemical Equations).

EQUATOR, *ee KWAY tur*, is the great circle of the earth that lies halfway between the North and South poles. This imaginary line divides the earth into two equal parts called the Northern Hemisphere and the Southern Hemisphere. The equator is the starting point for the degrees of latitude that measure distances north and south from the equator to the poles (see LATITUDE). Thus, the latitude of the equator is zero. On a globe, the equator is also the line on which equal distances are marked to show degrees of longitude, which measures east and west distances (see LONGITUDE). The circumference of the earth at the equator is 24,902 miles. Thus, each degree of longitude at the equator equals 69.17 miles.

The location of the equator can be determined by observing the elevation of the North Star or the sun above the horizon. Allowing for slight corrections, the angle of elevation of the North Star at any given place equals the latitude of that place. Thus, at the equator, the North Star is barely visible above the horizon and has an elevation of nearly zero degrees.

The Equatorial Region. At the equator, the days and nights are always of equal length, 12 hours each. This is because the *circle of illumination*, or the line that separates darkness from daylight, and the equator are both great circles. All great circles *bisect* each other, or cut each other into two equal parts. Thus, half of the equator is always in the zone of darkness, and half in the zone of daylight. See EARTH (color picture, The Earth Spins, or Rotates).

The region where the equator lies is called the *equatorial belt* or the *doldrums* (see DOLDRUMS). The doldrums lies between two trade-wind belts, and is a zone of calm (see TRADE WIND). But it also has rising air currents that produce heavy rains.

The climate along the equator varies according to altitude and the distance from the sea. In the equatorial lowlands, heavy rains and uniform temperatures are common throughout the year. But the east coast of Africa has only light rain and a long dry season. Quito, Ecuador, which lies almost exactly on the equator, has an elevation of 9,350 feet. It has a uniform temperature about 25 degrees cooler than nearby lowland regions. See ECUADOR (picture, An Indian Woman).

The Celestial Equator is an imaginary circle that goes around the sphere in which the earth and heavenly bodies lie. It helps locate stars and planets.

The Magnetic Equator is the line on which all points are equally distant from the north and south magnetic poles. See MAGNETIC EQUATOR. SAMUEL N. DICKEN

EQUATORIAL CALM. See WIND (Causes of Wind).

EQUATORIAL ISLANDS. See LINE ISLANDS.

Crossing the Equator is a time for special ceremonies aboard ship. King Neptune holds court to pass judgment on the *polliwogs*, those who have not crossed the equator. He initiates them into *The Ancient Order of Shellbacks*. The Queen, Davy Jones, and the Royal Baby help carry out his orders.

Moore-McCormack S.S. Line

EQUESTRIAN ORDER, *ee KWES trih un,* was a class of society in ancient Rome, made up chiefly of rich businessmen. Originally the members of the equestrian order served in the cavalry. They were called *equites,* a Latin word meaning *horsemen* or *knights.* Later, their military significance declined, but their social importance and political power grew. They became only slightly inferior to the senatorial class, and rivaled its power. Gaius Gracchus, who ruled Rome in 122 B.C., recognized them as a political group. He appointed them to government posts. They served as jurors in the criminal courts and as tax collectors for the province of Asia. During the latter days of the Roman Republic, the equestrians sometimes allied themselves with the people. But at other times, they stood with the senators when the poorer classes threatened their power.

During the Roman Empire, equestrians enjoyed public careers comparable to those of senators. Augustus and other emperors appointed them to such offices as viceroy of Egypt, commander of the Praetorian Guard, superintendent of the grain supply, and other civil-service offices. ROBERT S. ROGERS

See also GRACCHUS; ROMAN EMPIRE (Government).

EQUILIBRIUM, in physics. See GRAVITY, CENTER OF; LEVER; STATICS.

EQUILIBRIUM, in physiology. See EAR (How the Ear Controls Balance; picture: How We Keep Our Balance).

EQUILIBRIUM, *ee kwih LIB rih um,* **CHEMICAL,** is a state of balance that is reached when chemical reactions have apparently stopped. Most chemical reactions can proceed in both a forward and a reverse direction. This is shown by writing the chemical equation with a pair of arrows; for example, $N_2 + 3H_2 \rightleftharpoons 2NH_3$. If the amounts of N_2, H_2, and NH_3 in a mixture are not changing, the substances are in chemical equilibrium. Both the forward and the reverse reactions still take place rapidly at equilibrium, but their speeds have become exactly the same. Temperature and pressure affect the percentage of each chemical compound in an equilibrium mixture.

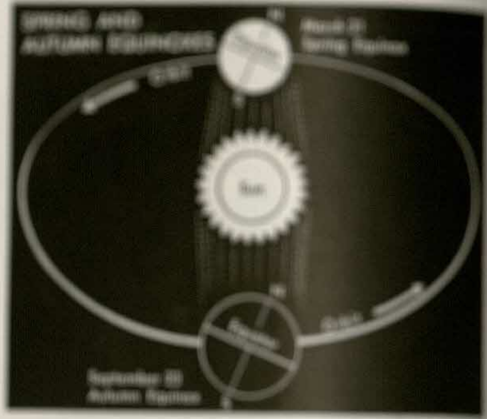
Delicate chemical equilibriums control many important life processes, such as the intake and release of oxygen in the blood. WALTER J. MOORE

See also REACTION, CHEMICAL.

EQUINE ENCEPHALOMYELITIS. See SLEEPING SICKNESS.

EQUINOX, *EE kwih nahks,* is the time of year when the center of the sun is directly over the equator. The word *equinox* means *equal night.* The word *equidies,* or *equal day,* would have been just as fitting, because during an equinox the days are the same length as the nights all over the world. The sun crosses the equator twice a year, and so there are two equinoxes. The spring, or *vernal,* equinox occurs around March 21, as the sun moves north. The autumn, or *autumnal,* equinox comes around September 23, as the sun moves south.

Storms that arise during an equinox are sometimes called *equinoctial gales,* for a very good reason. At this time the sun travels north or south faster than at any other time of the year. In a week it moves over 2¾°, or half the distance between the two pointers in the Big Dipper. This change in the sun's position produces such variations in the pattern of warm and cold air masses that violent storms are often caused. See WEATHER.



The time from the end of the vernal equinox to the beginning of the autumnal equinox is longer than the interval between the autumnal equinox and the following vernal equinox. This difference amounts to seven days each year, or six days in leap years. It is caused by the elliptical shape of the earth's path around the sun. The earth moves faster when it is nearer the sun. Around January 1, the earth is nearest the sun, and about July 1, it is farthest away.

Precession of the Equinoxes. The center of the sun does not always cross the equator at the same equinoctial point. Each year, the sun crosses the equator about 50 seconds of arc west of the point where it crossed the year before. This westward movement of the equinoctial points is called the *precession of the equinoxes.* The attraction of the sun and moon upon the equatorial bulge of the earth causes the earth's equator to change in regard to the apparent path of the sun across the sky and the celestial equator. This attraction is called the *lunisolar precession,* because it is caused by the moon, *Luna,* and the sun, *Sol.* Every year it causes the earth to twist slightly to the east, so that the sun appears to be moving west. If the sun and moon were the only influences on the earth's precession, the vernal equinox would move about 50.4 seconds of arc a year. But the planets also exert a pull which causes an eastward movement of seconds a year, and is called a *planetary precession.*

The North Celestial Pole is the point in the sky above the earth's North Pole. Because the whole earth twists as a unit, the north celestial pole swings in a large circle among the stars in the same period of time. The brightest star within a few degrees of arc of this circle becomes the *polestar* for thousands of years, while the north celestial pole is in its vicinity. The celestial pole is now approaching the star *Polaris,* which is now called the polestar, or North Star.

Because of precession, the signs of the zodiac no longer correspond to the constellations for which they were named. Over 2,000 years ago the sun was in the part of the sky called *Aries* at the spring equinox, and it is still called the *first of Aries.* It is now in the constellation *Pisces,* and is moving on toward the constellation which is called Aquarius in the zodiac. CHARLES J. HA

See also EARTH (The Earth Is a Traveler); EQUATOR; SEASON; SOLSTICE; ZODIAC.

EQUITABLE LIFE ASSURANCE SOCIETY. See INSURANCE (table, 25 Largest Life Insurance Companies).

EQUITY, *EK wuh tih,* is a body of rules that grew up as a way of righting certain wrongs for which the law gave no relief. The term *equity* comes from the Latin word *aequus,* which means *fair,* or *equal.* The rules of equity today are part of the laws of many countries and of most states of the United States.

The most common example of the use of equity is the ordinary mortgage. A person who borrows money with a mortgage promises to repay it by a certain day, called the law day. He also agrees to give up some valuable property if the money is not paid on the law day. He could be held to this agreement by the strict letter of the law. But a court might find that the man had to give up property of much greater value than the money he owed. Under the rules of equity, the court could order the mortgaged property sold, pay the man's mortgage debt in full, and give him the rest of the money. This is a fairer solution to the problem.

Its Beginnings. Equity, like many other legal institutions of the United States and Canada, can be explained in terms of the history of the laws of England. Hundreds of years ago, English courts often applied the rules of law strictly. Sometimes this resulted in hardships for the innocent, or even in rewards for wrongdoers. Some persons asked the king to step in and promote fairness, or equity, in these cases. The king and one of his ministers, the chancellor, began a system of judging certain kinds of cases on principles of justice, rather than the strict letter of the law. Soon the chancellor appointed judges to enforce his equity powers, and created courts where these judges presided. These courts were called *courts of equity,* or *courts of chancery,* in contrast to *courts of law.* In the late 1300's, one court of chancery was instructed with these words: "Let there be done that which right and reason and good faith and conscience demand in the case."

Originally the rules of equity and the rules of law were enforced in different courts. Courts of equity did not have juries. A law court considered justice done if a person was repaid after some damage had been done. But equity courts had the power to order a wrongdoer to stop some harmful act before it was committed, if money could not compensate for the damage afterwards. Equity courts also relieved persons of the consequences of a legal mistake, or of a fraud, when law courts in similar cases would observe the letter of the law, which would prove to be unfair to the victim of the mistake.

Court of Equity is a court which administers the rules of equity, instead of basing its decisions on the rules of law. In the United States, some states have separate courts of law and of equity. But, in most states, the ordinary law court handles cases either at law or at equity as they come up. In other states, the same court will sit as a court of equity or as a court of law at different times.

Court of Chancery in the United States is another name for a court of equity. A few states have separate courts of chancery presided over by a *chancellor.* The *master in chancery* is an officer appointed to serve as an assistant to the chancellor. See CHANCELLOR.

High Court of Chancery in Great Britain included the Court of the Lord High Chancellor of Great Britain, separate courts of the three vice-chancellors, the court of the master of the rolls, and a court of appeal in chancery. The High Court was the highest court next to Parliament. In 1873, it was merged with others to form the High Court of Justice. The principles of equity have been made part of the law and taken over by the regular law courts. [illegible]

See also COMMON LAW; INJUNCTION; MORTGAGE; WRIT.

ERA. See EPOCH.

ERA OF GOOD FEELINGS. See MONROE, JAMES (His administration as President); UNITED STATES, HISTORY OF (The Era of Good Feelings).

ERASER is a device for removing pencil, ink, or chalk marks from paper or some other surface, usually by rubbing. Rubber was so named because of its early use for rubbing out pencil marks. Good pencil erasers are soft enough not to damage the paper, and crumble gradually when used. [illegible] remove the marks without removing them completely. A yellow compound called [illegible] is used on surfaces that damage easily by rubbing. Ink erasers contain powdered pumice or a similar material that removes some of the paper below the mark and exposes a clean surface. This method of erasing requires less skill than the old one of scraping with a sharp knife. Some writing inks can be removed with erasing fluids. These fluids usually consist of a hypochlorite and an acid applied in succession, and then removed by blotting. [illegible]

ERASMUS, *ih RAZ mus,* **DESIDERIUS** (1466?-1536), was the foremost Christian humanist of the Renaissance (see HUMANISM). A scholar and Latin stylist, he worked for a reform of the Roman Catholic Church through his writings. He was ordained a priest in 1492. After studying at Paris from 1495 to 1499, he went to England, where he met John Colet and Sir Thomas More. They encouraged him to study Sacred Scripture. Erasmus made a new edition of the New Testament in Latin, and the first edition of it in Greek in the western world in 1516. He then edited the works of the Latin and Greek Fathers of the Church.

[illegible]

Erasmus

Erasmus tried to arouse interest in reform. In works like *Adages* and *Praise of Folly,* he criticized with wit and satire the ignorance of many of the clergy, their failure to educate the people, and their reliance on ceremonies and the letter of the law to the neglect of charity and the study of the Bible. His *Christian Soldier's Manual* reveals his ideal of Christian living: charity in one's actions.

Erasmus did not attack the teachings of the Church. He refused to follow Martin Luther in his revolt from the Roman Catholic Church because he believed in the unity of Christendom. Erasmus was born in Rotterdam, The Netherlands. [illegible]

ERATO. See MUSES.

ERBIUM (chemical symbol, Er) is one of the rare-earth metals. Its atomic number is 68. It has an atomic weight of 167.26. It has six known isotopes. The Swedish scientist Carl Mosander first discovered erbium in 1843. Erbium is found associated with the rare earths ytterbium and gadolinium, chiefly in the mineral gadolinite. It is best separated from the other rare earths by ion-exchange processes (see Ionization). It is available commercially in considerable quantities of high purity. The metal has a grayish-silver color. It melts between 2,732°F. and 2,860°F., and boils at about 4,700°F. Erbium forms a rose-pink oxide, Er_2O_3, that dissolves slowly in many acids. [illegible]

See also Element, Chemical (table); Rare Earth.

ERCILLA Y ZÚÑIGA, ALONSO DE. See Latin American Literature ([illegible]).

EREBUS, *EHR* ee bus, was the name of one of the sons of Chaos in Greek mythology. He ruled the mysterious kingdom of darkness beneath the earth. The spirits of the dead passed through his gloomy caverns on their way to Hades (see Hades).

His sister Nyx represented the dark and somber goddess of Night, and was worshiped by the ancients with solemn ceremony. Erebus is also another name for the Lower World. Padraic Colum

EREBUS, MOUNT. See Antarctica (The Land); Mountain (color picture, Mountains of the World).

EREMOTHERIUM. See [illegible].

ERFURT, *EHR* foort (pop. 188,000), is an historic city in East Germany, about 65 miles southwest of Leipzig. More flower seeds have been grown in and around Erfurt than near any other city in the world. Erfurt has been a trading center since the 1400's. At that time, the city became the chief commercial center of central Germany, because of its manufacture of woolen and cotton materials. James K. Pollock

ERG. See Dyne.

ERGOT, *UR* got, is a parasitic fungus that attacks wheat, barley, rye, and many wild and cultivated grasses. It most commonly infects rye. Ergot attacks the grain of the plant. Long purple structures of the fungus called sclerotia form in place of the seeds of the host plant. In the spring these sclerotia grow and produce stalks and spores. The spores ripen and are scattered by the wind to infect new plants.

Ergot infection can be reduced or prevented by rotating crops, using clean seed, and cutting those grasses which may harbor the disease.

Ergot also causes a disease called ergotism in human beings and cattle. This disease was common among people who ate bread made from infected rye grain. The symptoms were often gangrene and convulsions. The disease has now practically disappeared because of improved methods of cleaning grain. Ergotism was also known as *St. Anthony's fire.*

Ergot is the source of a number of drugs, such as ergonovine, ergotamine, and ergotoxine. These are used to produce powerful contractions of the involuntary muscles such as blood vessels, bladder, stomach, intestines, and uterus. The most common use of these drugs is to cure migraine headaches and to prevent hemorrhage after childbirth. [illegible]

See also Fungi.

ERIC THE RED (A.D. 950?-1003?), a Norseman, explored Greenland and led the first colony there in 985. He was born [illegible] in southwestern Norway. While Eric was still a boy, his father was outlawed for manslaughter. Eric helped him escape to Iceland, where several Norse settlements already existed. After his father died, Eric married and built a house on a grant of land. But he became involved in several quarrels. Finally, he too was declared an outlaw, and he fled to escape his enemies.

Eric collected some supplies, loaded his family and his dogs, and sailed away from Iceland. Risking everything, he headed westward into the unknown ocean. This was in 982. His sentence as an outlaw lasted three years. When the time was up, he sailed back to Iceland. He told an exciting story about a new land he had found which at first seemed to be all ice. But he had followed its coast southward, and had come upon green country. It was full of deer and so green that he named the place Greenland. Although he did not know it, this was a huge island in the Western Hemisphere. Thus, Eric became the first European to record a voyage across the Atlantic Ocean.

Many of Eric's neighbors in Iceland decided to sail back to Greenland with him. Some ships sank in a storm, but the others got through safely. The first colony stood near the site of present-day Julianehaab. The colonies the Norsemen founded in 985 lasted for about 400 years. [illegible]

See also Ericson, Leif; Greenland (History).

ERICSON, LEIF, a Norse explorer, was the son of Eric the Red of Greenland. Leif was one of the first men to visit America.

He sailed across the Atlantic Ocean from Greenland to visit Norway in about A.D. 999. He became a Christian in Norway, and decided to introduce the new religion to his father's pagan colony in Greenland. For several years, he traveled about Greenland teaching Christianity.

It was probably in 1003 that Leif sailed west from Greenland to seek the strange land about which he had heard. He and his crew first sighted what historians believe was Newfoundland, and then sailed along the coast to what was probably Cape Cod in Massachu

Leif Ericson, below, led his men to what is believed to have been the first voyage to America, in about A.D. 1000, right.

[illegible]

[illegible]

See also Eric the Red.

ERICSSON, *ERR ik sun,* **JOHN** (1803-1889), a Swedish-American engineer and inventor, [illegible]

John Ericsson

[illegible]

See also Propeller.

ERIE, [illegible]

[illegible]

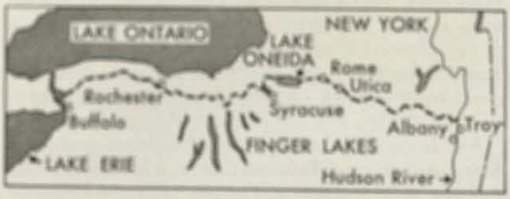
ERIE, LAKE. See Lake Erie.

[illegible]

The Landlocked Harbor of Erie, Pa., [illegible]

Brown Bros.

A Trip on the Erie Canal was a slow, but beautiful, journey in the early days. The heavy boats were pulled by horses at a speed of about a mile and a half an hour. Passengers paid a cent and a half a mile to travel on the state-owned waterway. The boats were crowded with passengers on the westward trip, and with freight on the trip east.



The Route of the Erie Canal, which connects the Atlantic Ocean with the Great Lakes. Cargo boats can journey up the Hudson River, by way of the canal, to the Great Lakes.

ERIE CANAL was the first important waterway built in the United States. It extended across New York from Buffalo on Lake Erie to Troy and Albany on the Hudson River. The canal was completed in 1825. It joined the entire Great Lakes system with the Atlantic Ocean. The canal provided a route over which manufactured goods could flow into the West, and raw materials could pour into the East. The Erie Canal helped New York City develop into the greatest financial center in the country.

The building of the canal was paid for entirely by the state of New York. It cost $7,143,789, but it soon earned its price many times over. Between 1825, when the canal was opened, and 1882, when toll charges were abolished, a total of $121,461,891 had been taken in by the state. Freight charges for carrying goods from Buffalo to Albany fell during the first ten years from $22 to $4 a ton.

The original canal was 363 miles long. It was 28 feet wide at the bottom, 42 feet wide at the top, and 4 feet deep. It could carry boats that were 80 feet long and 15 feet wide, with a draft of 3½ feet. A larger canal was soon needed, and in 1835 the New York legislature passed a law providing for improvement of the canal. By 1862, the canal had been enlarged several times.

The development of railroads made the canal less important after the Civil War, and its business began to fall off. The state authorized the spending of $9,000,000 to improve the canal in 1895, and in 1903 the people of New York voted a bond issue of $101,000,000 to make the canal part of a great modern waterway. The Erie Canal was combined with three shorter canals in New York to form the New York State Barge Canal. This canal, with a length of 525 miles, was opened in 1918. See New York State Barge Canal.

The Building of the Erie Canal. For a hundred years before the Erie Canal was built, men had been talking about a canal which would join the Great Lakes and the Atlantic Ocean. The man who planned the Erie Canal and carried the plans through was De Witt Clinton. Those who opposed the canal laughingly called it "Clinton's Ditch." Clinton talked and wrote about the canal and even drew up plans for it. He and Gouverneur Morris went to Washington in 1812 to ask for federal help in financing the project. But they were unsuccessful. At a great meeting in 1815, it was decided that the New York legislature should be petitioned to undertake the building of the canal. Clinton wrote the petition, and it won so much support that in 1816 the governor appointed a canal commission and made Clinton its head. Clinton became governor in 1817, and shortly afterward, on July 4, 1817, broke ground for the canal at Rome, N.Y., a village on the Mohawk River. For eight years an army of workmen labored in the rough country between the Hudson River and the Great Lakes. The first section of the canal was completed in 1820. As the canal grew, towns along its course prospered.

Clinton was still governor when the canal was completed in 1825. The first boat to make the entire trip along its route was the *Seneca Chief*, which left Buffalo for New York City on October 26, 1825. Governor Clinton and other noted citizens were on board. The boat was greeted all along the way by the ringing of bells, the booming of cannon, and the shouts of enthusiastic crowds. There were no telephones or telegraphs in those days, but news of the opening of the canal was sent from Buffalo to Sandy Hook, a distance of more than 500 miles, in 81 minutes. This was done by means of can-

Opening of the Erie Canal in 1825 joined the waters of the eastern United States with those of the West. Governor De Witt Clinton of New York symbolized this union when he poured water from Lake Erie into the Hudson River.

Visual Education Service

non placed along the way. The firing of each gun was the signal for the next to fire.

Travel on the canal was slow in the early days. The famous New York editor, Horace Greeley, said in his book of recollections that passengers traveled a mile and a half an hour on the Erie Canal for a cent and a half a mile.
W. Turrentine Jackson

See also Clinton, De Witt.

ERIGENA, *ee RIDG uh nuh,* **JOHANNES SCOTUS** (810?-877?), an Irish philosopher and theologian, became famous throughout Europe for his learning. He made one of the first attempts to work out a systematic Christian philosophy. His most important book, *On the Division of Nature*, stated a theory based on Neoplatonic sources (see Plotinus). These sources led Erigena into heresy, and his writings were condemned by the Roman Catholic Church. Since his day, other philosophers have tried to develop a "Christian Platonism."
W. T. Jones

ERIGERON. See Fleabane.

ERIN. See Ireland.

ERITREA, *EHR uh TREE uh,* is a territory on the east coast of Africa that is federated with Ethiopia. It lies between Sudan and the Red Sea. For location, see Ethiopia (map). Mountains over a mile high cover much of Eritrea's 45,754 square miles. Its coastal plain is one of the hottest and driest spots in Africa. Massawa, one of the coastal cities, has a mean annual temperature of 86°F. Less than one twentieth of the land is under cultivation, but 80 per cent of the people work in agriculture. Eritrea has a population of about 1,086,000. Its chief products include cereals, coffee, figs, oil seeds, and tobacco.

Eritrea, a former Italian colony, was captured by the British in 1941, during World War II. It became federated with Ethiopia in 1952. It is self-governing in internal affairs. Asmara is the capital of Eritrea (see Asmara). Eritrea's chief port, Massawa, also serves northern Ethiopia.
George H. T. Kimble

ERMINE, *UR min,* or **STOAT,** *stoht,* is a weasel that lives in cold climates and turns white in winter. The animal usually is called an ermine only when its fur turns white. Ermine also applies to the white fur itself. The ermine has short, silky fur that looks brown in summer and changes to a yellowish white in normal winter weather. In extreme cold, it turns pure white. But the ermine always has a black tip on its tail. The ermine is an extremely bloodthirsty and ferocious animal for its

The Ermine's Coat turns pure white in extremely cold winter weather. During the summer months, its short, silky hair is brown.

U.S. Fish and Wildlife Service

F.S.A.

Many Farms in the United States were abandoned after the fertile topsoil was washed away as the result of erosion caused by rainfall.

Smiley

Wind-Blown Sand will gradually bury and kill even large and deep-rooted trees.

DAMAGE CAUSED BY EROSION

F.S.A.

Water Combines with Other Elements to lay waste much good land. Such a huge gully as this probably began as a small trench on the hillside. It grew deeper and broader with every rain.

size. It eats small animals, birds, and eggs.

The best ermine comes from northern Canada, Russia, Sweden, and Norway. Ermine trappers must have great patience and work in bitter cold weather. The animals can be caught in steel traps, deadfalls, and snares.

A large ermine pelt measures about 12 inches long, and a finished garment or fur piece requires many pelts and is expensive. Ermine is used for fur wraps, jackets, capes, neckpieces, muffs, and trimmings for various garments. It decorates the robes worn by the judges of some countries. When used as an emblem of royalty, it is known as *miniver*. At one time, noblemen wore different arrangements of the black tail tips as signs of their rank.

The brown fur of the ermine's summer coat has also been in vogue as a trim for cloth coats and as neckpieces. This fur was formerly called summer ermine but a ruling of the Federal Trade Commission now prohibits use of this name.

Scientific Classification. The ermine belongs to the family *Mustelidae*. It is classified as genus *Mustela*, species *erminea*. HAROLD E. ANTHONY and MAX BACHRACH

See also ANIMAL (color picture, Color Protects Them); FUR.

EROS. See CUPID.

EROS, *EE rahs*, an asteroid, was discovered by the German astronomer G. Witt in 1898. It can come to within 14,000,000 miles of the earth at its closest approach—much nearer than Venus or Mars. Its apparent positions, as seen from different points on the earth, can be determined exactly when it nears the earth. The latest favorable approach took place in 1931. At that time, astronomers throughout the world cooperated to make accurate observations. This led to a new value for the astronomical unit (distance from the earth to the sun), the basic yardstick in the scale of the solar system. See also ASTEROID. CHARLES ANTHONY FEDERER, JR.

EROSION, *ee ROH zhun*, is the wearing away of earth or rock. This natural process works slowly but surely. In hundreds of thousands of years, erosion can wear away a mountain until it is level with the plain. The surface of the earth is always being changed and modified by erosion.

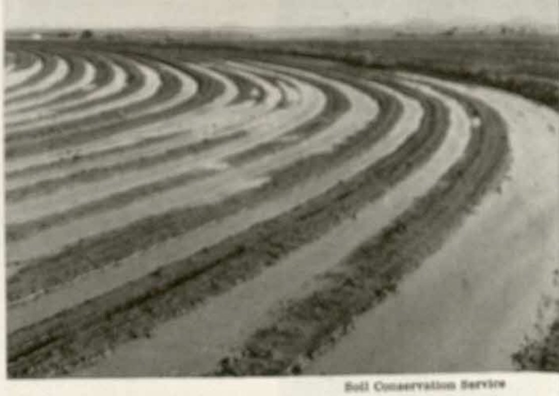
The main causes of erosion are the actions of air and water, and changes in temperature. Rainfall, running water, waves, ice, and wind all help to wear away earth and rock.

Weathering changes the earth's surface by both chemical and physical action. Through chemical weathering, rocks break down by the action of oxygen, carbon dioxide, and moisture, which absorbs organic acids from decaying animal and vegetable matter. Part of the rock finally is changed into soil and the rest is dissolved. Extreme weather changes, such as freezing and thawing, also make rocks break near the surface. Chemical weathering is most important in damp regions. In dry regions, physical, or mechanical, weathering is the principal cause of erosion. The wind, especially in dry areas, constantly wears away the surface of soft rocks, sometimes leaving the rocks in strange shapes.

Running water carries loose soil, sand, gravel, and boulders and deposits them in new places. Pounded and rubbed together by the current, they are dragged along the stream bed to carve new channels. Canyons are "dug" by erosion. The Grand Canyon in Arizona was cut during thousands of years of erosion by the Colorado River (see COLORADO RIVER; GRAND CANYON NATIONAL PARK). Rivers slowly change their courses by this kind of erosion. Mountain streams bring fine soil and sand to a river, which deposits the material on the river bed, along the banks, and at the mouth of the

Sawders

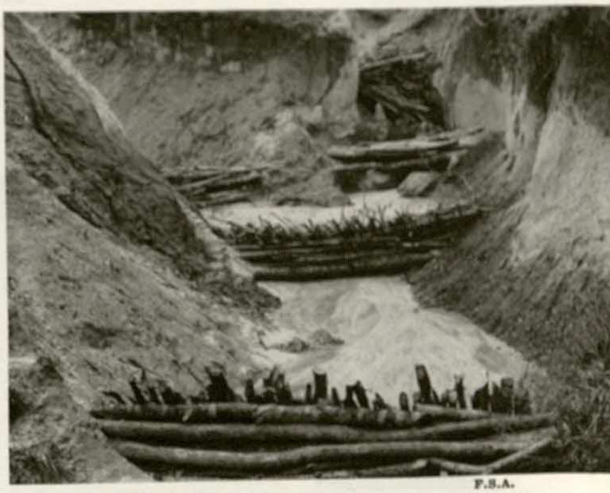
Coarse Grass Planted in Sandy Soil. When the grass spreads, its roots keep the wind from blowing the soil away.



Soil Conservation Service

Contour Plowing prevents soil from washing away. This modern method stops erosion and conserves precious rainfall.

HOW EROSION CAN BE CONTROLLED



F.S.A.

Water Erosion Control methods include the use of log dams. Earth washed down from higher levels gradually fills the gully.

river. This kind of erosion and deposition forms great fertile deltas, like that of the Mississippi River.

Ice throws up banks of sand and gravel on the shores of small lakes. Great sand dunes, such as the Indiana and Michigan dunes, are sometimes formed by wind acting on such banks. Rocks are worn away by ice. In the Rocky Mountains and the Alps, glaciers continually change the surface of the mountains. In the Ice Age, ice caused erosion in a great part of the Northern Hemisphere as glaciers advanced and retreated across the land (see ICE AGE).

Forests Protect Land from destruction by erosion. Rain which falls on bare land strikes with greater force than rain which falls on grass and vegetation. When rain strikes the bare land, it carries some of the topsoil down the slope with it. In time, gullies can be worn in the land, down which the rain carries fertile soil. Forests help prevent this destruction of the land by erosion. The leaves break the fall of the rain. The roots of grass and the matting of decayed leaves form a sod which absorbs much of the water. The water sinks into the ground. This prevents floods as well as erosion. Some of the absorbed water finds its way finally to springs and streams, feeding them continuously. ELDRED D. WILSON

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Wind

ERSKINE, JOHN (1879-1951), gained popularity in the 1920's as the author of comic novels about legendary characters, such as *The Private Life of Helen of Troy* (1925), *Galahad* (1926), and *Penelope's Man* (1928). He also wrote several nonfiction works on English and American literature.

Erskine was a man of remarkable energy. In addition to writing more than 50 books, he was a successful pianist and a distinguished professor of literature. His most enduring achievement was his contribution to Columbia University's program in the humanities, one of the major developments of the 1900's in American university education. Born in New York City, he was educated at Columbia University, where he received his Ph.D. in 1903. ARTHUR MIZENER

ERSKINE COLLEGE is a coeducational liberal arts college at Due West, S.C. It is controlled by the Associate Reformed Presbyterian Church. Courses lead to B.A. and B.S. degrees. A special South Carolina collection is in the school's library. Erskine was founded in 1839. For enrollment, see UNIVERSITIES AND COLLEGES (table).

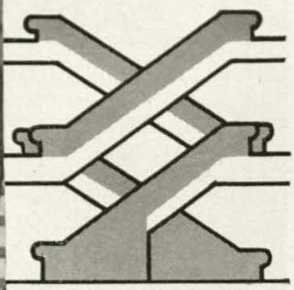
ERVINE, ST. JOHN. See DRAMA (The Irish Revival).

ERYSIPELAS, *EHR ih SIHP uh luhs*, is an infectious, or catching, disease of the skin. It is sometimes called Saint Anthony's fire. Bacteria that enter the skin through a scratch or cut cause erysipelas. It produces redness, swelling, and burning of the skin. The patient also has fever and chills, headache, and loss of appetite, and is restless. Erysipelas usually appears on the face or scalp, but may affect other parts. Pain in the joints sometimes accompanies it. Pus formation may follow inflammation of the skin. The disease occurs more frequently in men than in women.

Terrible epidemics of erysipelas, once quite common, seldom occur now, because of advanced methods of sanitation and hygiene. Erysipelas is sometimes a severe disease in alcoholics, babies, women after childbirth, and others in a weakened condition. Treatment of erysipelas includes the use of antitoxin, penicillin, sulfa drugs, local applications, and tonics. LEON H. WARREN

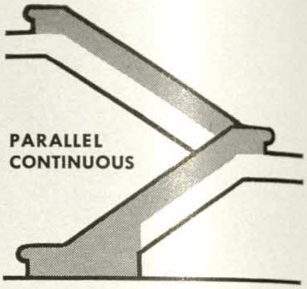
Otis Elevator Co.

ESCALATOR

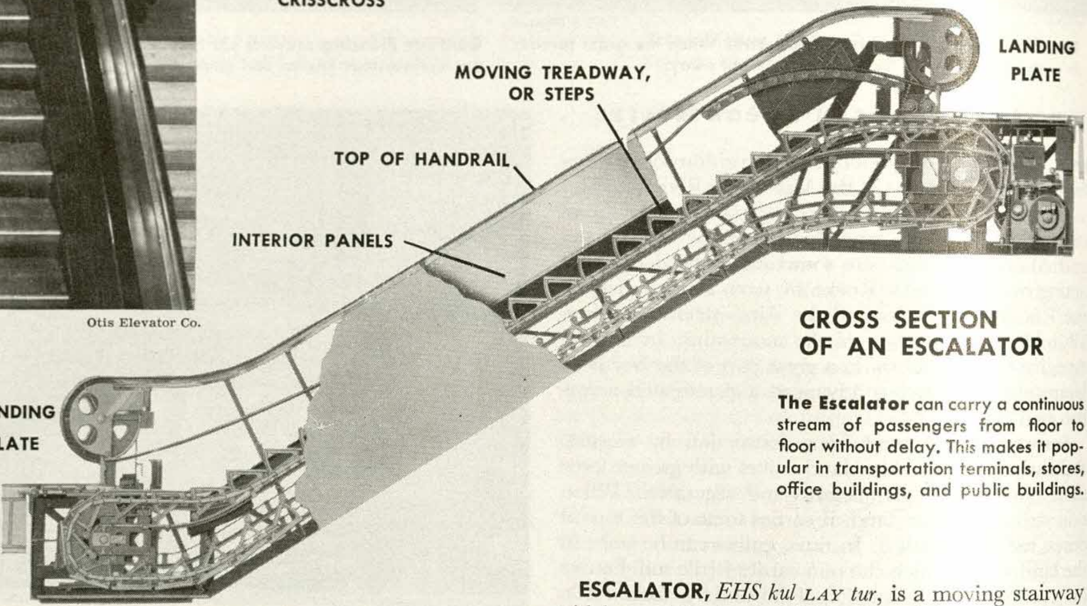


CRISSCROSS

Escalators efficiently move large crowds either up or downstairs with no supervision. A 32-inch-wide escalator, traveling at 90 feet a minute, can carry 85 passengers a minute, or about 5,000 in an hour.



PARALLEL CONTINUOUS



CROSS SECTION OF AN ESCALATOR

The Escalator can carry a continuous stream of passengers from floor to floor without delay. This makes it popular in transportation terminals, stores, office buildings, and public buildings.

ERYTHEMA, *EHR ih THEE muh,* is a redness of the skin. It is related to an increase in the amount of blood present in the *capillaries,* or small blood vessels, of the skin. The skin reacts to slight injury with erythema, which can be produced in many ways. For example, exposure of the skin to sunlight for a short time will cause erythema.

Longer exposure results in the formation of blisters, known as sunburn. A sharp slap will also produce erythema in the contacted area. Erythema is also a symptom of some diseases. W. B. YOUMANS

ERYTHROMYCIN. See ANTIBIOTIC (Kinds).

ERYTHROPHOBIA. See PHOBIA.

ERZGEBIRGE. See GERMANY (Location, Size, and Surface Features).

ESARHADDON. See BABYLON (History).

ESAU, *EE saw,* was the son of Isaac and Rebecca, and twin brother of Jacob in the Bible. He is a main character in many stories found in Genesis 25-33. The best known are Jacob's cheating him out of his birthright for a "mess of pottage" (Gen. 25:27-34), and the loss of his blessing through the plotting of his mother and brother (Gen. 27). Esau was reconciled to Jacob after the latter's return to Palestine 20 years later. Biblical history regards Esau as the founder of the Edomite nation. MERRILL F. UNGER

See also ISAAC; JACOB.

ESCALATOR, *EHS kul LAY tur,* is a moving stairway widely used in stores and in railroad, bus, and air terminals. The passenger stands on the steps, and the escalator carries him either up or down, depending on the direction it is running. The steps run on an endless belt. At top and bottom, the steps fold so that two or three of them are level with the floor, making a moving platform that allows the passenger to step off without tripping.

Moving sidewalk escalators have also been built. A person may stand on the sidewalk and be carried along without walking. The first escalator was installed by the Otis Elevator Company at the Paris Exposition in 1900. In 1901, the Paris machine was taken down and re-installed in Gimbel Brothers' store in Philadelphia. DONALD SHANNON

ESCAPEMENT. See CLOCK (Parts of a Clock).

ESCAROLE. See ENDIVE.

ESCARPMENT. See GEOLOGY (Some Terms Used in Geology).

ESCHEAT, *ehs CHEET,* is the turning over of property to the state when no owner claims it. Such a right may be exercised by the state when there is no heir, in which case the estate reverts to the state. In some states, bank deposits and bank dividends which have been unclaimed for a certain period may escheat to the state. When the heirs of an estate cannot be found, the estate is usually sold publicly, and the money is turned over to the state. WILLIAM TUCKER DEAN

See also ESTATE.

ESCHENBACH, WOLFRAM VON. See Minnesinger.

ESCORIAL, *ehs KOH rih ul,* is an enormous building about 25 miles from Madrid, Spain. It combines a convent, a church, and a palace, and is a burial place for the former kings of Spain. Philip II built it between 1563 and 1584. Because his soldiers had defeated the French on Saint Lawrence's day, Philip dedicated the Escorial to this saint. It is said that the architects planned the building in the shape of a gridiron, because Saint Lawrence was roasted on one.

This splendid structure appears grim and gloomy on the outside, but it contains some magnificent rooms and courts. These include the great domed church, and the monastery cloister called the Court of the Four Evangelists, with its lovely central fountain. Philip II, and all but two of his successors down to Ferdinand VII, were buried beneath the church. G. Holmes Perkins

See also Madrid (picture).

ESCORT CARRIER is a type of aircraft carrier. In the United States Navy, it is the lightest carrier, and has the popular name of *baby flattop.* The navy officially designates the ship as *CVE.* The escort carrier displaces about 20,000 tons, or about 30,000 tons less than the navy's huge attack aircraft carriers. About 20 fighter-bombers can take off and land on the escort carrier's flight decks. The ship mounts antiaircraft guns along the sides of the decks. A type of escort carrier called the *amphibious assault ship* carries troops and equipment and lands them by helicopters.

Escort carriers may be used as antisubmarine escort for cargo ships, and sometimes for troopships. The aircraft carried by these carriers maintain a constant aerial patrol against enemy submarines, and stand ready to meet an attack from enemy airplanes. Escort carriers may also be used to ferry short-range bombers to battle zones, and to replace aircraft lost in action. The bombers attack enemy positions on islands and seacoasts to prepare for an invasion by land troops.

The navy developed the escort carrier during World War II, and had more than 100 in use. It built most of them from unfinished merchant ships. T. C. Gillmer

See also Aircraft Carrier.

ESCROW, *EHS crow.* You may have heard one child say to another: "I won't give your pen back until you tell me where you hid my hat." The reply is often: "Give me the pen first."

When adults get into this "You first" kind of situation, they sometimes make use of a device called *escrow.* For example, a man may say to his relatives, "If you will let me live in your house and look after me, I shall leave you my farm." The relatives may say, "That is certainly fair enough, but how do we know you will do it? You may quarrel with us and decide to change your will, or you may marry, in which case your wife would be entitled to some of the property no matter what your will said. Give us a deed to the property now and we shall be glad to look after you for the rest of your life." Probably the man in our story will not care to do this, for if he did, his relatives would own the farm and could then take care of him or not just as they pleased.

He can solve the problem by making a deed which gives the farm to his relatives and placing the deed in the hands of some third person, to be delivered to his relatives if they have looked after him and cared for him until his death. Such a deed, or any other written document made by one person for the benefit of a second and placed in the hands of a third to be held until conditions are satisfied, is called an escrow. It guarantees the owner's right to his property until he dies, when it goes to the person or persons he has designated in the deed. William Tucker Dean

See also Deed.

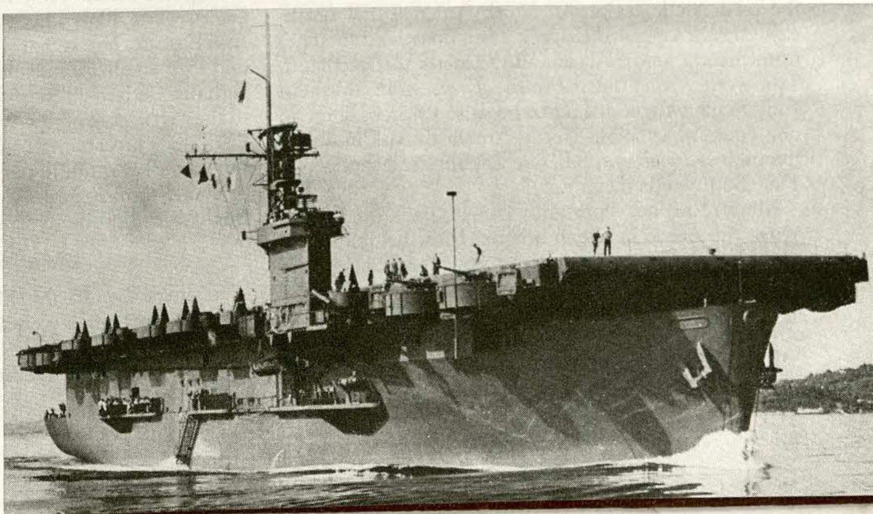
ESCUDO, *ehs KOO doh,* is the monetary unit of Portugal, equal to 100 centavos. This nickel bronze coin replaces the gold milreis, which was worth about 54 cents. The name was also used for coins of Spain, Mexico, Peru, and Chile, all of which are now obsolete. For the value of the Portuguese escudo, see Money (table, Values of Monetary Units). See also Centavo.

ESCUTCHEON. See Heraldry.

ESDRAELON, *EZ druh EE lun,* **PLAIN OF,** is a large fertile plain in northern Israel. The name Esdraelon is another form of the Hebrew *Jezreel,* which means *God has sown.* In Biblical times, many caravan routes crossed Esdraelon. The cities of Megiddo, Taanach, and Beth-shan stood along its edges. Esdraelon was often a battleground. The earliest Biblical battle there was the defeat of the Canaanite Sisera by the Israelite Barak (Judges 4, 5). On the eastern edge of the plain, Gideon's band of 300 men drove out the Midianites (Judges 7). Later, the Philistines defeated Saul at Esdraelon (I Sam. 31). Many battles have been fought on the Plain of Esdraelon since. The region is sometimes called Armageddon. W. W. Sloan

See also Armageddon.

ESKER. See Glacier (Structure).



U.S. Navy

This U.S. Navy Escort Carrier was one of the "baby flattops" of World War II. It is of the *Casablanca* class. Such aircraft carriers were stationed along Atlantic shipping lanes so that their planes could hunt and destroy Nazi submarines.

ESKIMO

Richard Harrington, Three Lions

Eskimo Families are extremely affectionate. They especially love children, and seldom punish them. Eskimos often display affection for each other by pressing their noses together.

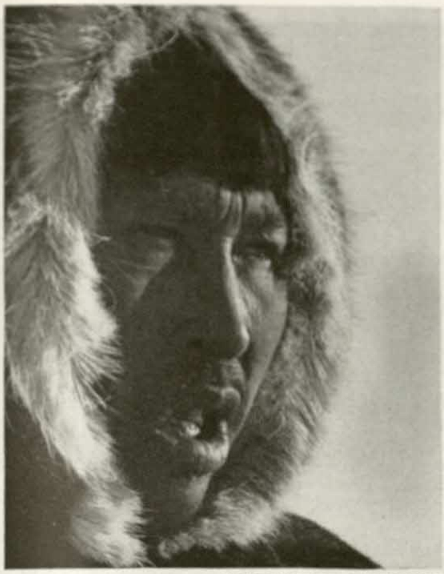
ESKIMO, *ESS kih moh.* The hardy people who live in the cold Arctic regions of North America and northeastern Asia are called *Eskimos*. Their homeland stretches from Siberia across Alaska and Canada to Greenland. The word *Eskimo* means *eaters of raw meat.* Northern Indians gave them this name because Eskimos often do not cook their food. North American Eskimos call themselves *Innuit* and Siberian Eskimos call themselves *Yuit*. Both words mean *men*.

Many Eskimos constantly move back and forth across the Arctic in search of food. Most Eskimos have similar customs and speak the same basic language. One group of Eskimos, the Aleut, developed a way of life that was different from, but still related to, that of other Eskimo groups (see ALEUT).

Like the American Indians, Eskimos belong to the Mongoloid stock. They have straight black hair, dark brown eyes, high cheekbones, and wide faces. But Eskimos are not Indians. Eskimos have shorter arms and legs, smaller hands and feet, and lighter skin than Indians. Certain physical features help keep them warm in the severe cold of the Arctic. For example, an Eskimo has a thick layer of flesh on his face, and his short, stocky body holds warmth better than the body of a tall, thin person. Eskimos are known for their good humor and their warm hospitality to strangers.

Life of the Eskimos

Eskimos live in the bleak, almost treeless, north. Summers in this region are so short that large trees cannot grow there. Snow covers the ground for months at a time. The homeland of the Eskimos is the country



Richard Harrington, Three Lions

Mac's Foto

The Great Cold of the Arctic has made it necessary for the Eskimos to develop special ways of living. The hunter, *above*, has typical Eskimo features. He wears a fur-trimmed parka, and lets his hair fall low on his forehead to keep it warm. A little boy, *right*, is dressed in his best, with an embroidered parka and fur mittens made to look like animal heads.

of the midnight sun. During part of the summer, the sun shines around the clock. But, in the middle of winter, the sun cannot be seen during the day for several weeks. Winter blizzards often send the temperature down to −60° F. Warmer summer weather brings clouds of flies and mosquitoes. But the Eskimos have developed a way of life that makes it possible for them to live in this cold northland.

The People. The world's 50,000 Eskimos are usually divided into four main groups. The *Western* group includes about 15,800 Eskimos who live along the coasts of Alaska and on nearby islands. They usually live in permanent settlements. Their region has always had more people than other parts of the Arctic, because of the plentiful supply of animals for food. The *Central* group of about 9,700 Eskimos lives in the Canadian Arctic, where food is scarce and the people must hunt constantly for game. The *Eastern* group includes about 850 Labrador Eskimos and more than 22,600 Greenland Eskimos, often called *Greenlanders*. This group moves about from place to place. The 1,200 *Yuit*, who live in northeastern Siberia, form the fourth group. These Eskimos herd reindeer for a living.

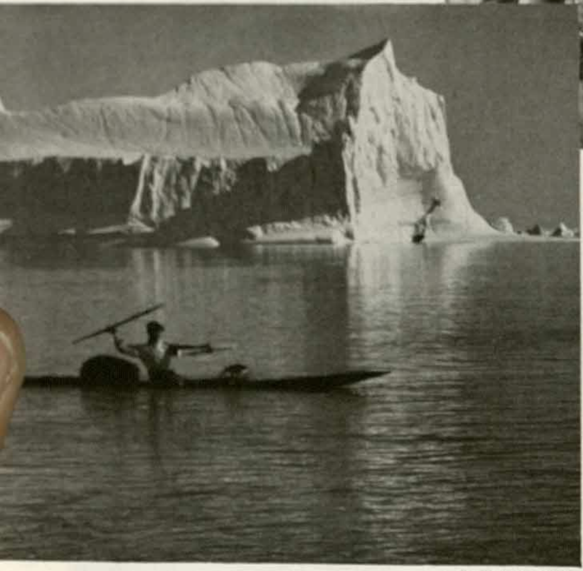
Language. All Eskimos speak the same language, although it varies a little from one area to another. (The Aleut dialect, though different in many ways, is basically Eskimo.) The language, called *Eskimoan*, is quite complicated. The average Eskimo, for example, knows many different words for seal, depending on whether the animal is young or old, in the water or on the land. The English language has taken over some Eskimo words, such as *igloo*, *kayak*, and *parka*. Missionaries

Fritz Goro, Life, © 1956 Time, Inc.

An Eskimo Woman eats from a pile of caribou bones. Caribou provide Eskimos with food, clothing, tools, weapons, and covering for tents and boats.

Richard Harrington, Three Lions

Fishing Through the Ice, *above,* requires a great deal of skill and patience. A fisherman sometimes sits for hours, watching and waiting. He must act quickly when a fish swims into view. The fish in the foreground are arctic char, a kind of trout.



An Eskimo Hunter, *left,* holds his harpoon in readiness to strike. The kayak in which he sits is fragile and tips easily, so he balances himself by holding the paddle in his free hand. Eskimos who live near the water rely heavily on sea animals such as walrus and seals for their food and other necessities.

Luthy, Black Star

developed an Eskimo alphabet, so that Eskimos could read and write their own language. In addition, most of them know some English, Greenlandic, or Danish.

Family Life. The family is the main group in Eskimo life. Unlike American Indians, Eskimos have no tribes. Several families may live together in a settlement during the winter, but these groups are only temporary. They change constantly as one family moves out to hunt or another comes in. The food supply always controls the size of these bands. The people usually scatter in summer, when everyone hunts and fishes. Eskimos love children. Boys are especially favored, because they grow up to be hunters.

Eskimos have no regular form of government and no chiefs, but they highly respect successful hunters. They have rules of good conduct rather than a system of strict laws. An Eskimo who misbehaves is shamed by public laughter, or is banished from the community. The most important rule is that everyone helps in the search for food.

Shelter. Many Eskimos have two homes, one for summer and one for winter. In summer, they live in tents. Some buy canvas tents at trading posts run by white men. But others still prefer to make their tents of animal skins.

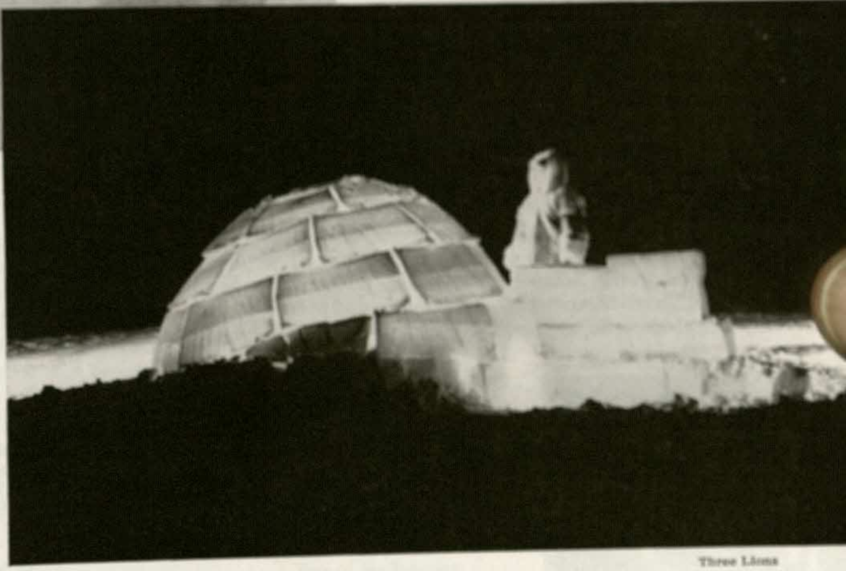
Eskimos usually build their winter homes to last several years. They build three main types of winter homes. In Alaska, where driftwood is plentiful, they usually make the homes of timber. Sometimes they use whalebones. They cover the outsides of the buildings with earth and sod. Eskimos in Labrador and Greenland do not have large pieces of driftwood, so they use flat stones to build houses. Both these types of houses are much alike inside. At the back of the room stands

National Film Board

Wooden Houses, *above,* line a street in Frobisher Bay, a trading post in the Northwest Territories. Eskimos here have adopted many modern customs.

Fritz Goro, Life, © 1956 Time, Inc.

Tents made of poles and skins serve as homes for many Eskimos during the short northern summer. Women and children watch from shore as the men set out for the day's hunting.



Three Lions

An Igloo, *right,* lit from within by an oil lamp, glows eerily in the black arctic night. An additional wall protects the entrance to the snow house.

a raised platform, covered with grass or furs. Here the family eats and sleeps. A blubber or seal-oil lamp provides light and heat, as well as fuel for cooking. Sometimes the house has a stove and a table. Eskimos rarely have any other furniture. Some houses have window holes covered with seal intestines. Stale air escapes through a small hole in the roof.

Most Eskimos in the central Canadian Arctic build winter houses out of snow. White men often call this kind of shelter an *igloo*. But, to the Eskimos, *igloo* means almost any kind of dwelling, not just a snow house. To make a snow house, an Eskimo stacks blocks of wind-packed snow in a rising spiral of ever-smaller circles. He fills open cracks with loose snow. Eskimos are the only people in the world who build such a dome without using a support underneath. Heat from a lamp keeps the igloo snug and comfortable inside. The cold outside prevents the house from melting. The family eats and sleeps on a platform made of hard-packed snow and covered with furs. See IGLOO.

Each of the three types of winter homes has an entrance tunnel. The tunnel is lower than the floor of the house, and serves as a trap for the cold air outside. Cold air is heavy, and does not flow up into the house. If necessary, the people open a roof hole to let out stale air and draw up cool air for ventilation.

Food. Eskimos get most of their food from the sea. They eat the flesh of seals, walruses, fishes, whales, and sea birds. The caribou is the most important land animal. Eskimos boil some meat, but often eat it uncooked because fuel is so scarce. They like raw meat and a fatty soup with seal or caribou blood in it. Sometimes they eat the undigested contents of a caribou stomach, or gulp down small live fishes head first. Eskimos get vitamins and minerals by eating almost every scrap of the animals they kill, including organs such as the heart, liver, and digestive tract, which have high food value. Most Eskimos have extremely strong teeth, because their food rarely contains sugar. Chewing tough, uncooked meat makes their jaws powerful.

Clothing. Eskimo women make almost all the clothes for their families. They cut animal skins with an *ulu*, a flat steel knife shaped like a piece of pie. They stitch the skins together with animal sinew, or tendons, and often chew the leather to soften it.

Men, women, and children all wear the same type of clothing: a *parka*, or hooded jacket; trousers; *mukluks*, or boots; and mittens. The parka fits snugly around the neck and head, but hangs loosely below the hips. The trousers are belted at the waist and hang over the boots. These clothes are designed to allow ventilation. At the same time, they hold the warm air that rises around the body. In very cold weather, an Eskimo may wear two complete sets of clothing. He wears the inner set with the fur inside, and the outer set with the fur outside. A man who hunts in a boat sometimes wears an extra parka made of waterproof seal intestines.

Eskimos use caribou skin for their clothing, because it is both light and warm. A set of man's clothing, including two full suits, requires 12 caribou skins. Boots are made of seal and have soles of tough, watertight walrus hide. Eskimos often decorate their clothes with fox, wolf, or bear fur. They sometimes wear goggles to cut down the glare of sunlight on the snow. They make these goggles out of flat pieces of wood or bone, and cut one or two thin slits to peer through.

Recreation for the Eskimos usually comes during the winter and spring, when several family groups live together. There is little daylight for hunting, and people must stay indoors for long periods. They hold ceremonies called *drum dances*, at which they dance and tell stories handed down from father to son for many generations. In Alaska, the Great Feast of the Dead is an elaborate ritual that honors ancestral spirits. Many guests take part in the dancing and singing. Eskimo children like to play outdoors. They play tag, build little snow houses, and pull each other about on sleds.

Activities of the Eskimos

Hunting and Fishing. Before white men taught Eskimo hunters to use rifles, they used stone- or metal-tipped harpoons to kill sea animals and swimming caribou. Many hunters still use harpoons, because this weapon makes no noise to frighten other animals away. The Eskimo harpoon has a short foreshaft and a longer throwing shaft. The hunter holds onto a leather thong tied to the foreshaft, and throws the harpoon at his prey. The head and foreshaft come off in the animal's flesh, but the hunter holds onto them with his thong. If the animal escapes, the hunter still has the main shaft of scarce, valuable wood. See HARPOON.

Eskimos hunt whales from boats, but they usually stalk seals and walrus on the ice. When a hunter finds an animal's breathing hole in the ice, he waits quietly until the animal comes up for air. Then he harpoons it and pulls it up through the ice.

Most Eskimos now use rifles instead of bows and arrows for shooting caribou on land. They catch birds with nets, spears, or *bolas*, a kind of sling (see SLING [Bolas]). Fishermen use spears, hooks, or nets. They fish from boats or through holes in the ice. Many Eskimos make their living by trapping foxes. They exchange the pelts for food and other items at trading posts.

Transportation. In winter, Eskimos haul game and equipment on sleds pulled by teams of dogs (see DOG SLED; ESKIMO DOG). They build their sleds of wood and bone, and fasten them together with rawhide. They coat the runners with frozen mud to make the sleds

Eskimo Life and Customs today have become a mixture of old and new ways. Eskimos who live in towns have discarded many of their former habits. A group in Nome, Alaska, *left*, enjoys ice cream cones in front of a local store. School children, *below*, in Frobisher Bay, N.W.T., learn to read and write by working simple puzzles. The soapstone carvings of a hunter and a walrus, *below left*, represent traditional Eskimo life, as well as the craftsman's continuing interest in good design and workmanship.

Van Sprang, Black Star; National Film Board

glide easily. Eastern Eskimos hitch each dog separately, and the team spreads out like a fan. In the west, the Eskimos hitch their dogs in pairs, with one pair of dogs in front of the other.

In summer, water travel is fastest and most common, but Eskimos sometimes use dogs to carry packs on their backs. They have two types of boats, the one-man *kayak* and the large *umiak*. They make a boat by tying a wooden frame together with rawhide. Then they stretch wet walrus hide over the frame. As the leather dries, it shrinks to fit the frame. See KAYAK.

Education. Eskimo children are usually taught at home by their parents. They are rarely punished, but learn that good behavior earns the respect of their families. As they grow older, girls help with the housework and boys learn to hunt with their fathers. Many Eskimo children also attend free government or mission schools. Younger children may go to school only in summer or only in winter, but older pupils attend classes all year long. Classes are usually held in English or Danish, depending upon the locality.

Religion among the Eskimos centers around the food supply and anything connected with it. The people believe that human beings have three spirits. They believe that one of these spirits will have a future life, that the second gives life and warmth to the body and leaves it at death, and that the third represents possible evil and stays with the body after death. The Eskimos believe that all objects and animals also have souls. Animal spirits must be respected, because animals provide food, clothing, and other materials important to Eskimo life. The people believe that the souls of sea animals such as the walrus, seal, and whale are especially important. These souls live in the underwater world ruled by Sedna, the sea goddess. After an Eskimo kills a seal, he throws its bladder back into the sea. He believes that this action insures the future supply of seals. When an Eskimo dies, his body is sewed into a caribou skin and left on the ground or under a pile of stones. The people put food and weapons near the body to help the spirit in the afterworld.

The Eskimo "medicine man" is called an *angakok*. He is a magician with a special guardian spirit, and acts as a healer and weather forecaster for the Eskimos. The people believe that he brings them good luck in hunting. Many Eskimos who come into contact with white men have become Christians.

Arts and Crafts. Eskimos have few equals as artists and craftsmen. They are skillful woodworkers, and carve beautiful objects from bone and ivory. The people have a strong sense of beauty. They have little time for art in itself, but delight in decorating the objects they use every day. An Eskimo may make the buckles for kayak thongs in the shape of seals, or carve a knife handle in the shape of a fish or a man, or etch designs on his snow goggles. Almost everything Eskimos make —from the smallest harpoon head to the largest boat— shows their sense of artistic form and their pleasure in good design and fine craftsmanship.

History

The ancestors of the Eskimos, like those of the American Indians, probably came from Asia. The Indians are believed to have crossed over from Siberia many thousands of years ago, when dry land lay across what is now the Bering Strait. The Eskimos probably came by boat more than 2,000 years ago. Their way of life developed in the region that is now Alaska. Many generations of Eskimos spread over the land. They reached Greenland more than 1,000 years ago.

Contacts between Eskimos and white men have not always been happy. In the western Arctic, Eskimos suffered badly. Early explorers, whalers, and traders killed many Eskimos outright. These white men also destroyed herds of seals and caribou, leaving the Eskimos without any animals for food. Sometimes diseases brought by the white men wiped out whole settlements. New diseases also harmed Eskimos in the central Arctic, but they lived farther away from white men and suffered less. The Eskimos in Greenland have probably fared best of all, because the Danes treated them kindly. The Danish government has kept out most foreigners. It regulates trade in the interests of the Greenlanders, and provides free medical care and schooling. There has been much intermarriage between the Danes and the Eskimos.

In the 1900's, the U.S. Bureau of Indian Affairs has worked to prevent racial discrimination. Canada's Department of Northern Affairs and Natural Resources has promoted education, self-help, and slow changes in the Eskimo way of life. The United States and Canada sponsor a program to have Eskimos in the western and central Arctic raise Siberian reindeer, because these animals, unlike caribou, can be tamed. Eskimos served as guides, scouts, and construction workers in World War II. In the 1940's and 1950's, many of them found work in the growing white settlements of Alaska and northern Canada.

ELMER HARP, JR.

Related Articles in WORLD BOOK include:

Alaska (The People; color picture)
Aleut
Arctic
Art and the Arts (picture)
Caribou
Clothing (Clothing of Other Lands; color pictures)
Dog Sled
Eskimo Dog
Family (color picture)
Greenland
Harpoon
Igloo
Kayak
Labrador
Northwest Territories (pictures)
Races of Man (picture, The Americas)
Seal
Ulu
Walrus

Outline

I. Life of the Eskimos
- A. The People
- B. Language
- C. Family Life

II. Activities of the Eskimos
- A. Hunting and Fishing
- B. Transportation
- C. Education
- D. Religion
- E. Arts and Crafts

III. History

Questions

How do Eskimo women soften hides for making clothes and shoes?

When did the Eskimos come to North America?

Who is the *angakok?* What does he do?

Why do Eskimo hunters throw the bladders of seals back into the sea?

What does *Eskimo* mean?

How are Eskimos like American Indians? How are they different?

What does *igloo* mean to the Eskimos?

Why are boys favored in an Eskimo family?

What are the four main Eskimo groups? Where do they live?

National Film Board

Powerful Eskimo Dogs still furnish one of the principal means of transportation for families living in cold Arctic regions.

ESKIMO DOG is a dog from the cold Arctic zones. It is used to pull sleds. The name is often given to three pure breeds of dogs: the *Eskimo*, the *Alaskan malamute*, and the *Siberian husky*. These belong to a large group of dogs called *lupine*, because they sometimes have been mated with wild wolves.

All the dogs in the Eskimo family carry their tails above their backs to keep them from being hardened with frozen snow. They have furry outer hair, with another coat of fine hair next to the skin so that they never get "soaked to the skin." They can sleep outdoors in snowdrifts even in the coldest weather. Their ears are pointed and stand upright, and their faces are oval-shaped. The Eskimo dog has a heavy muzzle, and strong bones in his legs. His feet are large and hairy so he will not sink into the snow. Many Eskimo dogs lift their heads and howl instead of barking.

The dogs vary in weight from the Siberian husky female, which weighs about 40 pounds, to some which weigh 110 to 135 pounds. The Eskimo dog usually weighs around 85 pounds when it is grown. It has great courage, fighting ability, and endurance, which are necessary in a country where it is so difficult to survive.

Eskimo dogs are useful and valuable. The sleds which they pull are long and low, with space for supplies and a passenger. The driver usually walks, however, or runs along in the rear, riding a little every few minutes by standing on the rear of the sled. From three to eight dogs make a team. They may be hitched one behind the other to a long trace, or in groups of two or more side by side. Or each dog may be hitched separately so that the team fans out in an arc.

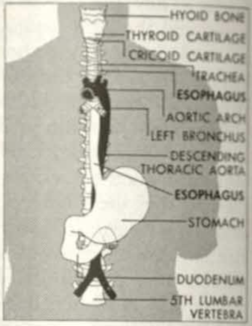
When the driver starts the dogs, he shouts "Mush!" The dog in front is the lead dog, and takes commands from the driver. He turns the other dogs, starts and stops them. The dogs can travel 20 to 40 miles a day, or more, and a team of five dogs can pull a load of 250 pounds. Sometimes the dogs carry supplies on their backs like pack mules. The lead dog is usually the master of the other dogs. This dog learns six or seven basic commands, such as "go," "stop," "faster," and "lie down." He is chosen to lead because of his intelligence, speed, and endurance.

Eskimo dogs are often used to hunt seal, bear, and musk ox. Many of them have excellent wind-scenting ability, and can locate air holes through which seals breathe.

HENRY P. DAVIS

See also DOG (color picture, Working Dogs).

ESOPHAGUS, *ee SAHF uh gus*, or **GULLET,** is the muscular tube that carries food from the lower part of the pharynx to the stomach. The muscles in the walls of the esophagus contract in a wavelike manner, moving the food downward into the stomach. Mucus produced by glands in its walls helps the movement of food by keeping the inner surface of the esophagus moist and slippery.



The Esophagus connects the throat with the stomach.

The human esophagus is about 10 inches long. The length varies greatly in different animals. The esophagus of fish is short, while that of the giraffe is very long. Birds have a saclike part of the esophagus called the *crop*, for the temporary storage of food.

WILLIAM V. MAYER

See also ALIMENTARY CANAL; DIGESTION; HUMAN BODY (Transvision color picture); SWALLOWING.

ESP. See EXTRASENSORY PERCEPTION.

ESPALIER, *ehs PAL yer*, is a method of training a fruit tree or shrub to grow on a trellis, on a lattice, or against a wall. The protection given by the wall makes it possible to grow fruit trees in climates that would otherwise be unfavorable. The term *espalier* is used both for the trellis on which a tree is trained, and for the tree itself when it is handled in this way. Trees trained on espaliers take up less space and are more ornamental than ordinary trees. The branches usually grow vertically, and must be pruned from time to time to maintain the desired shape of the tree. Trees used for espaliers are usually grown from dwarf roots, since the standard-sized tree grows too fast to permit proper pruning. Espalier trees are more common in Europe, especially France, than in the United States. See also TOPIARY WORK.

ESPAÑA. See SPAIN.

ESPAÑOLA, the name applied by Columbus to Haiti. See HISPANIOLA.

ESPARTO is the Spanish name of several coarse fiber grasses native to the dry lands of North Africa and Spain. In North Africa they are called *halfa* or *alfa*. Manufacturers use esparto to make fiber, shoes, brooms, mats, rope, and paper. Esparto rope is desirable for use on ships because it is light and will float. Great Britain imports large amounts of these grasses to make paper. Before manufacturers make the paper pulp, they extract from the plants a wax suitable for polishes.

Several kinds of needle grasses grown in the western United States are related to esparto. However, these are not suitable for use in industry. Farmers use them as inferior forage grasses.

Scientific Classification. Esparto grasses belong to the grass family, *Gramineae*. Two kinds, genus *Lygeum*, species *sparteum*, and *Stipa tenacissima*, are called esparto. The needle grasses all belong to the genus *Stipa*. RICHARD W. POHL

ESPERANTO, *es puh RAHN toh,* is an auxiliary language intended for people in all countries. Lazarus L. Zamenhof (1859-1917), of Bialystok, Poland, devised it. He published his first book in 1887 under the pen name of Dr. Esperanto, meaning *Dr. Hopeful*, from which the language takes its name.

Esperanto uses all letters of the Roman alphabet except Q, W, X, and Y. The language uses five accented consonants, and its spelling controls pronunciation. Its rules have no exceptions. The general principle of Esperanto is to use root words common to leading languages of Europe. Prefixes, infixes, and suffixes extend the vocabulary indefinitely. Consonants are pronounced practically as in English. The accent always falls on the next to the last syllable. The nouns always end in *o*.

Aa,	Bb,	Cc,	Ĉĉ,	Dd,	Ee,	Ff,
Gg,	Ĝĝ,	Hh,	Ĥĥ,	Ii,	Jj,	Ĵĵ,
Kk,	Ll,	Mm,	Nn,	Oo,	Pp,	Rr,
Ss,	Ŝŝ,	Tt,	Uu,	Ŭŭ,	Vv,	Zz.

The Esperanto Alphabet does not include the letters Q, W, X, or Y. Marks over the letters indicate a variation in sound which allows the spelling to be strictly phonetic.

Thousands of works now are available in Esperanto, including the Bible, classical and scientific books, and novels by such authors as Edna Ferber and Erich Maria Remarque. There also are more than 100 Esperanto newspapers and magazines published in about 30 countries. The language has been used at many international meetings, as well as by some chambers of commerce and tourist agencies. The Esperanto Association of North America has its headquarters at 114 W. 16th St. in New York City. I. A. RICHARDS

See also LANGUAGE (Auxiliary Language).

ESPIONAGE, *EHS pih oh nihj,* is the act of spying on a country, organization, or movement. Governments and other groups send secret agents called *spies* into an enemy area or a possible enemy area to gather information. They seek valuable military, political, scientific, and production facts and secrets. Men and women become spies for money or because they believe in the cause for which they spy. Sometimes, they may be blackmailed into espionage. They usually work as members of an organization through which they receive instructions and send back information. Spies have developed ingenious methods for gathering, handling, and sending this information.

Espionage is one of the main information-gathering parts of an intelligence organization. The agency evaluates and interprets bits and pieces of information from its agents. Its research experts gather data from publications. It pieces these bits of knowledge together, much as a jigsaw puzzle, until the whole picture can be seen. Such information helps in making policy.

Counterespionage usually is set up to foil espionage. It seeks to prevent the successful stealing of secrets. Agents may pose as spies to gain the confidence of real spies and to learn about the members and aims of the enemy spy system. Such agents are called *counterspies* or *double agents*. All countries have agencies that seek to safeguard information essential to national security. These agencies also gather information essential to the country's safety, military defense, or general well-being.

History. Espionage is as old as war. The ancient Egyptians developed it into a fine art. The Bible tells of Moses sending spies into Canaan. In modern times, Frederick the Great of Prussia is credited with originating systematically organized espionage.

George Washington's network of spies obtained intelligence and information for the Continental Army during the Revolutionary War in America. Allan Pinkerton directed espionage and counterespionage for the Union Army during the early days of the Civil War. Later, a Bureau of Information carried on this work. In World War II, the Office of Strategic Services conducted the government's overseas espionage and intelligence operations. In 1954, Congress passed a law making peacetime espionage against the United States punishable by death. The death penalty for espionage had been imposed previously only during wartime. In 1947, Congress established the U.S. Central Intelligence Agency to coördinate government intelligence activities and to carry on operations of its own. STEFAN T. POSSONY

See also CENTRAL INTELLIGENCE AGENCY; INTELLIGENCE SERVICE; SPY.

ESPIRITU SANTO, *ays PEE ree too SAHN toh,* or **SANTO** (pop. 4,000), is the largest of the New Hebrides Islands in the southwest Pacific. It is about 75 miles long and about 45 miles wide. The western part of the island is composed of volcanic mountains which rise to a height of 6,195 feet. Exports include copra, timber, and coffee. Espiritu Santo also has been called *Marina*. See also NEW HEBRIDES ISLANDS. EDWIN H. BRYAN, JR.

ESPRIT DE CORPS, *ehs PREE duh KAWR,* is morale, or the common spirit of the members of a group. It implies pride in the group, devotion, enthusiasm, and friendship. The phrase is French. See also MORALE.

ESQUILINE HILL is one of the seven hills of ancient Rome. See ROME (Location).

ESQUIRE. See ADDRESS, FORM OF.

ESSAY, *ES ay,* is a literary composition on some special subject, generally in prose. It is usually shorter and less formal than the systematic discussion of facts found in a treatise. Statements are argued less in an essay than in a thesis. The essay is also smaller in its scope than a biography or history. The term *essay* in a strict sense applies to informal writing which strongly reflects the personality of the author. Such essays are sometimes called *personal*, or *familiar*, essays. Much of their charm lies in their easy, natural style. But many essays are formal, impersonal, and direct. Sometimes philosophical treatises are called essays. John Locke wrote an *Essay Concerning Human Understanding*, and one of Alexander Pope's poems is called *Essay on Man*. The articles in most magazines are really essays, or developments of the essay form. Authors usually analyze and interpret information in them to prove a point.

Writing an Essay can be fairly simple work. But a good essay requires a good deal of thought. The first things to consider are what the essay is about and how it will be organized. An essay on some interesting topic is more enjoyable to read than one about something dull. A well-organized essay is easier to read and understand than one that is confused. Many authors outline their essays before they begin writing. Specific words are better than vague ones, and examples often illustrate ideas better than pages of explanation.

Essay Writers and Their Works. Such Greek and Roman writers as Plato, Cicero, Seneca, Pliny the Younger, Marcus Aurelius, and others produced works which can be classed as essays. Some of these works were in the form of written conversations between two persons, or *dialogues*, on philosophy. Others were letters intended for publication; moral treatises; or thoughts expressed in writing. Some were like the later French works called *pensées*, or thoughts. But the essay did not gain its position as a literary form until the Renaissance. A French writer of this period, Michel de Montaigne, first applied the word *essai* to his informal experiments with written conversations reflecting upon various ideas.

Francis Bacon composed the first works in English to be named *essays*. These consisted of a collection of compact bits of worldly wisdom. He arranged them under such general topics as truth, marriage, travel, youth and age, fear, and riches. Abraham Cowley (1618-1667) produced the first informal essays comparable to the works of Montaigne. Other writers of the 1600's portrayed familiar types of people in witty essays called *characters*.

Periodicals began publishing essays in the early 1700's. Richard Steele and Joseph Addison contributed the first periodical essays to *The Tatler* and *The Spectator*. Other British authors who wrote periodical essays included the Earl of Chesterfield, Oliver Goldsmith, and Samuel Johnson.

During the early 1800's, Charles Lamb and William Hazlitt developed familiar essays that were more personal than earlier ones. Many periodicals and reviews appeared, demanding essays to fill their pages. As a result, most prose writers of the period did much of their work in essay form. Among them were Matthew Arnold, Thomas Carlyle, Thomas De Quincey, Thomas Henry Huxley, Thomas Babington Macaulay, John Cardinal Newman, John Ruskin, and Robert Louis Stevenson. Later British essayists included Sir Max Beerbohm, Hilaire Belloc, G. K. Chesterton, Edmund Gosse, Aldous Huxley, and Virginia Woolf.

American Essayists. Thomas Paine wrote political discussions in the form of essays. But Washington Irving's essays in *The Sketch Book* were the first American works to develop in the European pattern. Ralph Waldo Emerson is often considered the greatest American essayist. But many other authors helped make the essay form popular. Oliver Wendell Holmes wrote *The Autocrat of the Breakfast Table*, Edgar Allan Poe produced essays on aesthetics, and Henry David Thoreau wrote *Walden*. These authors set patterns in writing humorous essays, art criticism, and essays about nature that are still followed. Recent essayists of note include Norman Cousins, Richard Rovere, James Thurber, Peter Viereck, and E. B. White.

J. N. HOOK

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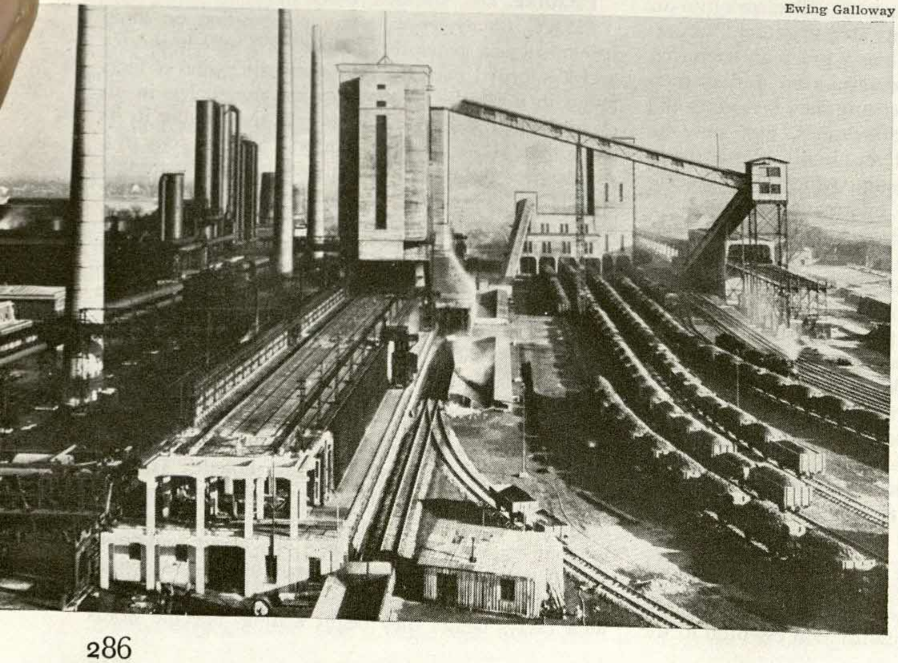
Thoreau, Henry D.
Thurber, James G.
White, "E. B." Elwyn
Wilson, Edmund

ESSEN (pop. 729,500; met. area, 4,795,000; alt. 269 ft.) is the largest industrial center in the Ruhr region of West Germany. See GERMANY (color map). The city owes its growth to the iron, steel, and war munitions industries. These industries include the famous Krupp factories, which supplied many weapons for German armies in World Wars I and II. Allied bombers demolished much of the city between 1943 and 1945. Postwar recovery has been rapid.

JAMES K. POLLOCK

Ewing Galloway



The Krupp Coke Plant in Essen, Germany, provided the fuel for the nearby Krupp munitions factories. Essen was a production center during both World Wars. This picture shows the huge plant before it was bombed during World War II.

ESSENCE has several meanings. It may be a solution which contains alcohol and certain oils that have an odor. These oils are called *essential oils*. Essence can also mean any liquid that has the same properties as the substance from which it came, such as essence of beef. *Essence* is a word philosophers use to explain the nature of things. Essence and substance are both contained in anything, but the substance is the same in all kinds of things, while the essence is the special nature that makes each kind of thing different. George L. Bush

ESSENES, *eh SEENZ*, were members of a Jewish sect living in Palestine from about 100 B.C. to A.D. 100. They numbered about 4,000 and had a communal life. Essenes were *ascetics*, and tried to avoid contamination by worldly impurity (see Ascetic).

In the 1940's, archaeologists discovered the remains of a monastery and several jars of scrolls, containing the oldest Biblical manuscripts yet found, at Qumran near the Dead Sea in Jordan. These scrolls may have belonged to the Essenes. Bruce M. Metzger

See also Dead Sea Scrolls.

ESSENTIAL OIL. See Essence; Perfume (Plant Perfumes).

ESSEQUIBO. See British Guiana (The Land).

ESSEX. See Connecticut (Interesting Places to Visit).

ESTABLISHED CHURCH. See Church of England.

ESTANCIAS. See Argentina (Country Life).

ESTATE is a legal term with several meanings. In its broadest sense, it includes everything that goes to make up a person's total wealth or fortune. The term is most often used at the present time in connection with the ownership of land.

In the days of the feudal system, estate meant the same things as *status*. It was not merely a legal term, but a word used frequently in ordinary conversation. One person might ask another to describe the nature of his estate as readily as we would inquire, "Do you own your home or do you pay rent?" The king owned the land in his realm. Private landholders were his tenants. They agreed to certain terms. A person's *estate*, or status, in connection with the land he held was the whole set of terms or conditions of his tenancy. The question: "What is your estate?" meant "What is the degree, quantity, nature, and extent of your interest in this piece of land?"

There are two kinds of estate, *leasehold* and *freehold*.

Leasehold depends upon a contract or lease (see Contract; Lease). Leaseholds differ from one another chiefly in the length of time the contract lasts. A contract may last for life, for a period of years, or from year to year. Some contracts can be ended at will.

Freehold involves some degree of ownership. In the United States today, there are two principal kinds of freehold estates: the estate in *fee simple*, which constitutes complete ownership; and the *life estate*, which gives the possessor an interest in the property only during his lifetime (see Fief). The estate in fee simple used to be thought of as absolute ownership. The owner was supposed to have the right to use or dispose of the land in any way he pleased. But many modern jurists question whether the old meaning of estate in fee simple, as so considered, can exist in a complex society such as ours. Some have said bluntly that there is no longer any such thing as ownership in fee simple. Some have wanted to redefine the estate in fee simple as "the most complete and thorough-going dominion over a piece of land that is possible within the existing framework of a given social organization."

A third kind of freehold is known as the estate in *fee tail*. Under common law the owner of such an estate could not sell or dispose of it, but had to leave it to some specified descendant, usually his eldest male heir. Sometimes this worked hardships, as when an owner had more property than he could afford to maintain and was not allowed to dispose of it. In such cases, the courts would sometimes break the entail and allow the sale of some or all of the property. In modern times, however, statutes in all jurisdictions have altered the meaning of a fee tail estate. William Tucker Dean

See also Dower; Entail; Escheat.

ESTATES-GENERAL. See States-General.

ESTER is a compound formed when organic acids react with alcohols. It is also formed when an alcohol reacts with an inorganic acid. Ethyl nitrite and nitroglycerin are esters which are found when ethyl alcohol and glycerol react with nitric acid. Many esters occur in nature. They are present in fats and oils. Often they are liquids which have a pleasant odor. Esters give perfumes to flowers, and give flavor to fruits. Banana oil is a common ester. George L. Bush

ESTES, ELEANOR (1906-), is a librarian and author of children's books. She received the Newbery medal in 1952 for *Ginger Pye*. But she became best known for *The Moffats*, *The Middle Moffat*, and *Rufus M*. These books are about family life in a small town. *The Hundred Dresses* deals with relationships among young girls. Eleanor Estes was born in West Haven, Conn. At the age of 18, she became a children's librarian in New Haven, Conn. After winning a scholarship, she studied at the Pratt Institute in New York City, and served for several years as a children's librarian in New York. George E. Butler

ESTES PARK. See Colorado (Interesting Places to Visit).

ESTHER was a beautiful Jewish girl whose story is told in the Old Testament book which bears her name. An orphan, Esther was raised by her cousin, Mordecai. When King Ahasuerus (or Xerxes) of Persia divorced his queen, Vashti, he chose Esther from among all the young women of his realm to be his wife. He did not know that she was a Jewess. Later, the king's favorite, Haman, became angry because Mordecai would not bow down to him. He got the king to decree that all Jews should be killed. But Esther, at the risk of her life, went to the king and told him that she was Jewish. Moved by Esther's plea, King Ahasuerus had Haman hanged on the very gallows prepared for Mordecai (see Haman).

The Book of Esther was written many years later. Some think that it is a historical novel. Although it does not mention God at all, it is a tale of unselfish courage and devotion. It seeks to teach how God preserves his people from their foes. The Jews still celebrate the Feast of Purim in memory of this deliverance (see Purim). John Bright

ESTHESIOMETER. See Touch.

ESTHETICS. See Aesthetics.

ESTIENNE FAMILY. See Book (Printed Books).

ESTIVATION. See Hibernation; Lungfish.

ESTONIA

Estonian Holiday Costumes usually include colorfully embroidered linen blouses.

European

ESTONIA, *es TOH nih uh,* is a land on the Baltic Sea in northern Europe. It was an independent country for twenty-two years. But, in 1940, Russia seized Estonia and made it a state of the Union of Soviet Socialist Republics. It is now called the ESTONIAN SOVIET SOCIALIST REPUBLIC. Many countries, including the United States, do not recognize the Russian seizure of Estonia. Such countries recognize Estonian diplomats and consuls who still function in many countries in the name of their former government. The capital and largest city of Estonia is Tallinn.

Estonia covers an area slightly smaller than the combined areas of Maryland and New Jersey. But these two states have about eight times as many people as Estonia. Stronger nations have fought for and controlled Estonia for hundreds of years. But the people have kept their own language, ancient folklore, and ways of life. They also have preserved an independent spirit in spite of often being controlled by other countries.

The Land and Its Resources

Location, Size, and Surface Features. Estonia is north of Latvia on the Baltic Sea. Its 724-mile coast line includes the Gulf of Rīga and the Gulf of Finland. Most of the land is a high plain, which rises from the sea in steep cliffs along the northern shore. Inland swamps and lakes dot the countryside. Lake Peipus is the largest lake in Estonia. It covers 1,300 square miles on Estonia's eastern border. The chief river is the Narva, which flows into the Gulf of Finland. Many islands lie off the Estonian coast. The two largest ones are Saaremaa and Hiiumaa. The *Map* shows that these are both off the western coast. Estonia covers 17,400 square miles.

Natural Resources. Estonia's soil is generally good for farming. There are many fields and meadows for grazing. Estonia has thick forests of fir, pine, and birch trees. Large underground deposits of oil shale furnish fuel oil.

Climate. Estonia has long, cold, snowy winters, and fairly cool summers. The average annual temperature is 50°F. Even in the summer, the temperature of the country seldom rises to more than a comfortable 70°F. About 20 to 40 inches of rain falls annually in most of Estonia.

The People and Their Work

The People. Most Estonians are tall and fair-haired. The Communists have deported about 120,000 Estonians, and have replaced them with people from other parts of Russia. More than 60,000 of the Estonian refugees live in other countries. The people of Estonia speak a language that is closely related to the language of Finland.

Way of Life. Estonian people are hard-working and energetic, but they love holidays and festivals. Holiday costumes are bright and colorful. The women wear full skirts with a striped design, and embroidered kerchiefs and blouses. The men wear blouses with soft collars, and short jackets edged with buttons. They also wear knickers and long stockings.

Before the Russians seized Estonia, many children spent their summers in children's colonies in the country. In the winter they went skating, skiing, and tobogganing for fun. Today, the Russian youth program encourages sports as a part of the training for military and labor service.

Cities. Tallinn (pop. 280,000) is the capital and largest city of Estonia. Tartu (pop. 74,000) serves as the cultural center, and Pärnu (pop. 43,000) is a leading seaport. Other cities, together with their populations, include Narva (43,600); Kohtla-Järve (30,000); Valga (25,400); Rakvere (21,500); Viljandi (19,700); Haapsalu (9,100); and Kingisepp (5,000). See TALLINN; TARTU.

Agriculture. Most Estonians are farmers. The climate and soil are good for growing grains and cool-weather crops. Potatoes are the most important crop, followed by rye, barley, wheat, and flax.

Herds of cattle and sheep graze on the broad fields. Estonia long produced enough butter and cheese for its own needs and for export. But, during World War II, many dairy cattle were killed. The Communists are making efforts to bring Estonia's stock of meat and dairy animals up to prewar size in order to expand the country's meat and dairy industries.

In 1948, the Communists began to collectivize Estonian agriculture. By 1950, more than four fifths of the farm land had been turned into collective farms. Machine-tractor stations serve the farmers.

Mining. Oil shale is Estonia's most valuable mineral. The largest deposits are in northeastern Estonia. Refineries process shale oil from these deposits. A 125-mile pipeline carries gas from Estonia's oil-shale industry to Leningrad. The region around Tallinn has some

FACTS IN BRIEF

Type of Government: State of Russia.

Capital: Tallinn.

Area: 17,400 square miles. *Greatest distance:* (east-west) 180 miles; (north-south) 150 miles. *Coast line,* 724 miles.

Population: 1,196,000. *Density,* about 68.7 persons to the square mile. *Distribution,* rural, about 67 per cent; *urban,* about 33 per cent.

Chief Products: *Agriculture,* barley, cattle, flax, pigs, potatoes, poultry, rye, sheep, wheat. *Mining,* oil shale. *Forest Industry,* birch, fir, pine. *Manufacturing and Processing,* cement, fuel oil, lumber products, machinery, textiles.

phosphate rocks. Fertilizer is made from these phosphates. Peat furnishes fuel for many Estonian industries (see PEAT).

Manufacturing is not widely developed in Estonia. Most manufacturing plants are government-controlled. The forests furnish material for the country's sawmills and paper and pulp industries, and for making furniture. Estonia also produces fuel oil, textiles, cement, and machinery.

Transportation and Communication. Estonia has more than 13,000 miles of highways and over 900 miles of railroad tracks. There are twenty ports, but Tallinn handles most of the country's shipping. Airlines join Estonia with other parts of Russia. A network of telephone and telegraph lines covers Estonia.

Social and Cultural Achievements

Education. When Estonia was a free nation, the law required all children between the ages of seven and fourteen to attend school. Nearly everyone in the country could read and write. Their training included handicrafts, gardening, and agricultural work, in addition to the usual school subjects. Estonia supported professional and technical schools that trained lawyers, doctors, dentists, engineers, artists, and musicians. Russian authorities have taken over all the schools.

Religion. Before the Communists seized Estonia, four out of five Estonians were Protestants. Most of them belonged to the Lutheran Church. The rest of the people were mostly of the Eastern Orthodox faith. But the Russian Government has tried to suppress religion in the country, and has replaced the Estonian heads of the Lutheran and Eastern Orthodox Churches, together with their pastors and priests.

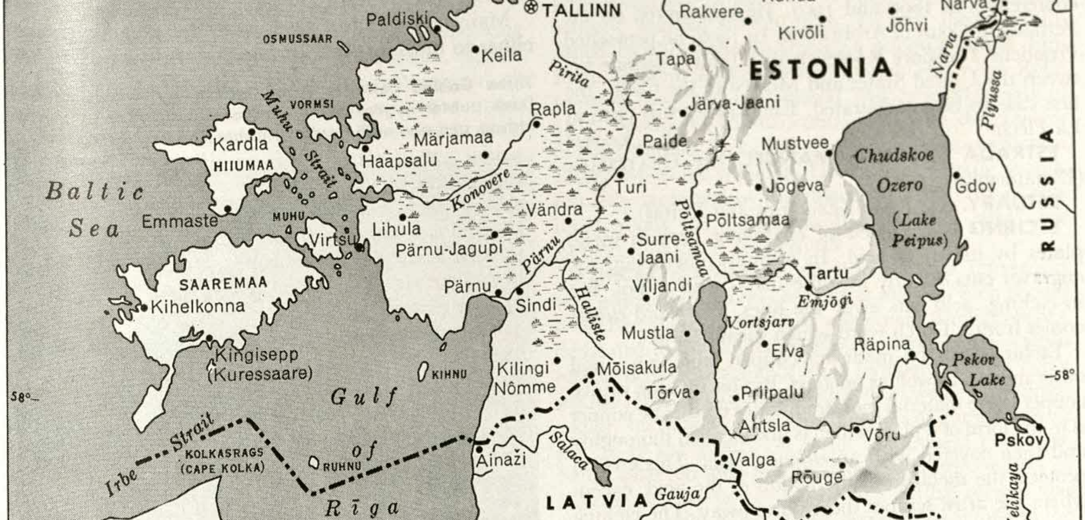
History and Government

Early Years. Estonians have lived along the Baltic Sea for thousands of years. Their early history may be divided into three periods. During the first period, the country was separated into several independent states. Elected elders headed each state. The Danes held part of Estonia in the 1200's. They were followed by the Germans in the 1300's. The Poles followed the Germans, and controlled part of Estonia in the 1500's.

The second period was from 1561 to 1710, when the Swedes controlled Estonia. The Swedes established many schools, and made the life of the farmers easier.

The third, or Russian, period began in 1710 during the Great Northern War. Sweden gave Estonia to Russia in the Treaty of Nystad in 1721. This treaty was signed at the end of the Great Northern War.

Independence. Estonia remained in Russian hands until 1918, when it declared its independence. The governments of Great Britain, France, and Italy recognized Estonia as an independent country. The Russians attacked Estonia in November, 1918. A German army also invaded Estonia. Its aim was to put Baltic nobility of German ancestry in control of the region. Estonia defeated the Germans in 1919, and the Russians in 1920. The Estonians and Russians signed a peace treaty in February, 1920, which confirmed Estonian independence. All Russian-held property in Estonia was turned



over to the Estonian government. Estonia adopted a democratic constitution in June, 1920. The first head of government was Konstantin Päts (1874-1957?). He governed from 1921 to 1924, and again from 1934 to 1940.

One of the first things the Estonian government did was to take over the large estates that had been owned mostly by the nobility. The government gave land to many of the men who had fought for the country's independence. It also distributed land to many other persons who formerly had worked on large estates.

In 1937, Estonia adopted a new constitution, based on the experience of its twenty years of independence. In 1939, Russia threatened to invade the country, and Estonia had to sign a new treaty with Russia. This treaty allowed the Russians to set up military bases in Estonia. It also permitted Russia to keep troops stationed in the country.

Russian Rule. On June 17, 1940, Russian troops entered Estonia. The communists set up a new government, which staged fake elections. Estonia was annexed as one of the states of Russia on August 6, 1940. In the next year, German troops invaded Estonia. The people suffered under the Germans until 1944, when the Russians re-entered the country.

The communists have collectivized Estonian agriculture and have nationalized all industry to meet Russian needs. The standard of living has dropped. Religion has been discouraged. Education has been changed to conform to Russian ideas. Russians have replaced a majority of Estonians in places of high authority.

FRANCIS J. BOWMAN

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Baltic States
Latvia
Lett
Lithuania
Russia
Tallinn
Tartu

ESTOURNELLES DE CONSTANT, *es toor NELL duh kawns TAHN,* **PAUL HENRI D'** (1852-1924), BARON D'ESTOURNELLES, was a French diplomat, political leader and author. In 1909, he received the Nobel peace prize. He served as a delegate to the Hague peace conferences in 1899 and 1907. He also served on the Permanent Court of Arbitration. In 1902, he persuaded President Theodore Roosevelt to submit a dispute between the United States and Mexico to the Court, the first case to be so arbitrated. Estournelles was born at La Flèche.

E. J. KNAPTON

ESTRADA CABRERA, MANUEL. See GUATEMALA (Dictatorship).

ESTUARY. See RIVER (Estuaries and Deltas).

ETCHING is a process of engraving lines in metal plates by means of acid. In ordinary engraving, the engraver cuts directly into the metal with a tool. But in etching, acid eats away the lines. The word *etching* comes from a Dutch word which means *to eat.*

Etchings can be made on copper, steel, zinc, and other metals, as well as on glass. But for making prints, copper is the material most frequently used. The copper is in the form of a plate which is first cleaned thoroughly and then covered with an *etching ground.* This ground protects the metal from the action of the acid, except where the artist scrapes the ground away. The etching ground is usually a composition of wax, gum resin, and bitumen.

Ewing Galloway

An Etcher Uses a Sharp-Pointed Tool to finish an etched plate. Such tools are ordinarily used only for cutting through the protective film to expose the plate to the acid.

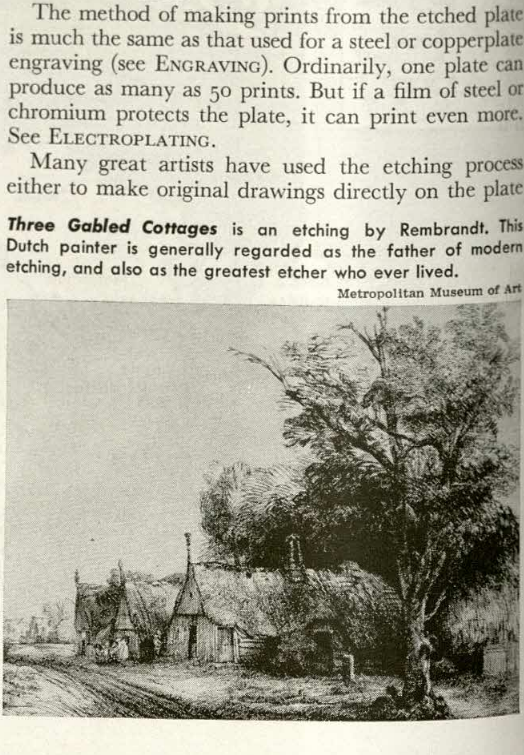
The artist draws or traces the design on the plate with any sharp instrument, usually an etching needle. Joseph Mallord William Turner, great etcher, engraver, and painter, actually used the prong of an old steel fork. The needle scrapes away the etching ground and leaves the design on a bare copper surface. The plate is then placed in an acid bath and allowed to remain until the acid eats away the exposed copper to the required depth. The depth of the groove varies according to the kind of line the artist wants to print. To get grooves of different depths, it is necessary to give the plate several baths in the acid. Any grooves which are already deep enough can be covered, or *stopped out,* with etching ground or a varnish. This keeps out the acid while the remaining grooves are being deepened. At one time nitrous acid always served as the etching medium. But nitric acid, hydrofluoric acid, iron perchloride, and a mixture of hydrochloric acid and chlorate of potash are now also used.

The method of making prints from the etched plate is much the same as that used for a steel or copperplate engraving (see ENGRAVING). Ordinarily, one plate can produce as many as 50 prints. But if a film of steel or chromium protects the plate, it can print even more. See ELECTROPLATING.

Many great artists have used the etching process either to make original drawings directly on the plate

Three Gabled Cottages **is an etching by Rembrandt. This Dutch painter is generally regarded as the father of modern etching, and also as the greatest etcher who ever lived.**

Metropolitan Museum of Art



or to reproduce their own paintings or those of other artists. Included among the Dutch and Flemish painters who were also great etchers are Rembrandt, Jacob Van Ruisdael, and Sir Anthony Vandyke. Great etchers of recent times include William Blake, James A. McNeill Whistler, Joseph Pennell, George Bellows, Anders Zorn, and Pablo Picasso. The World Book Encyclopedia has articles on these artists. S. W. Hayter

See also Aquatint; Glass (Etching); Photoengraving.

ETEOCLES. See Antigone.

ETERNAL CITY. See Rome.

ETERNAL LIGHT is a continuously burning flame, often used as a memorial. The *Flamme du Souvenir*, or Fire of Memory, is a memorial flame at the grave of France's Unknown Soldier, under the Arc de Triomphe in Paris. Another perpetual flame burns in the Eternal Light Peace Memorial at the Gettysburg National Military Park in Pennsylvania. President Franklin D. Roosevelt dedicated it on July 3, 1938. The limestone shaft and bronze urn acknowledge the good will between the North and the South. Charles L. Wallis

ETHANE, *ETH ayn* (chemical formula, CH_3CH_3), is a colorless and odorless gas. It is made up of carbon and hydrogen. Ethane is soluble in alcohol, but only slightly soluble in water. It freezes and boils at temperatures far below zero. Ethane is found in coal gas and natural gas. It can be made by adding hydrogen to ethylene or to acetylene. This gas is used to make acetic acid, ethyl alcohol, and ether. Ethane is the second member of the methane series of simple organic compounds called *hydrocarbons*. Methane is the first member of the series. George L. Bush

See also Hydrocarbon; Methane.

ETHANOL. See Alcohol.

ETHELBERT. See Augustine of Canterbury, Saint.

ETHELRED II (968-1016), an English king, was sometimes called "the Unraed," or counsel-less, because he could not command the support of his leading nobles. Today he is often called "the Unready" because that word looks like "Unraed." He failed to stop Danish invasions, and finally bought peace with money. This was the origin of the Danegeld (see Danegeld).

ETHELWULF, *ETH'l woolf* (? -858), became king of the West Saxons in England when his father, Egbert, died in 839. In 851, he became the first ruler in all western Europe to defeat a Viking army in a major battle. He was the father of Alfred the Great (see Alfred the Great). Ethelwulf traveled to Rome in 855, taking Alfred with him. Robert S. Hoyt

ETHER, *EE thur* (chemical formula, $(C_2H_5)_2O$), is a colorless, sweet-smelling liquid that can be made by the action of sulfuric acid on alcohol. Its chemical name is *ethyl ether* or *diethyl ether*. The fumes of this liquid will make a person lose consciousness if he breathes enough of them. Ether fumes bring on such a deep unconsciousness that major surgical operations can be performed on persons when they are under their influence. Substances that act this way are called *general anesthetics*. Ether is also used as a *local anesthetic*. When it is applied to a small part of the body, it first produces intense cold. Then, as it evaporates, it takes away the feeling from the surface of that part of the body.

Ether is considered a safer anesthetic than chloroform. It was nearly always used for major surgical operations in the United States, until other anesthetics were available. Ether sometimes irritates the kidneys, however, and may cause bronchial trouble. Otherwise, it is not dangerous to use, except for patients with weak hearts.

Frequently persons who have been given ether have unpleasant aftereffects, especially severe nausea or vomiting. There are several helpful remedies for this sort of nausea. If the anesthetic is nearly pure, the patient is much less likely to feel nausea when he wakens.

In 1846, William Thomas Green Morton, an American dentist, first proved publicly that ether was a valuable anesthetic. Credit for first using ether, however, goes to Crawford W. Long of Georgia. He used it in operations as early as 1842. Austin Edward Smith

See also Anesthesia; Long, Crawford W.; Morton, William T. G.; Warren, John C.

ETHER, in physics, is a substance that scientists once thought filled all space. In the 1800's, physicists believed that light and other forms of electromagnetic energy traveled in waves. They knew that these waves could travel through manmade vacuums, and through the empty reaches of outer space. But they could not explain how waves could travel without a *medium*, or substance, to travel through, as sound waves travel through air. The physicists found no direct evidence of any substance that existed in vacuums, so they proposed the existence of a *luminiferous*, or light-carrying, ether. This ether was supposed to be different from ordinary matter. It could not be seen, tasted, felt, or weighed. It existed in vacuums, through all outer space, and through all matter.

Doubt was cast on the ether theory in 1887. In that year, the American physicists Albert A. Michelson and Edward W. Morley designed an experiment to measure the relative motion of the earth and the ether. The results of this experiment were negative—Michelson and Morley found no evidence of motion of the earth through ether. See Michelson, Albert A.

After 1900, most physicists decided that the concept of ether was not needed to explain the transmission of light waves and other forms of energy. This change in attitude resulted mainly from the new theories published by the German-American scientist Albert Einstein. Einstein published his Special Theory of Relativity in 1905, and his General Theory of Relativity in 1915. Because of various contradictions in the concept of ether, and the lack of direct evidence for its existence, Einstein rejected the idea. He explained many events, formerly explained by the ether theory, in terms of new ideas about the properties of space and time. See Einstein, Albert; Relativity.

ETHICAL CULTURE is an international movement that emphasizes moral conduct as the goal men should seek. Members consider the movement a religious one dedicated to human fellowship and service. They stress ethical behavior in and of itself, independent of a belief in God. Ethical Culture societies hold weekly meetings, usually on Sunday mornings. Leaders or guest speakers lecture to the groups on social and ethical problems. Felix Adler founded the first Ethical Culture society in New York City in 1876. The first British society was founded in 1888. More than 5,000 persons belong to the movement. See also Adler, Felix.

ETHICS, or moral philosophy, is the study of human actions in respect to their being right or wrong. The actions of individuals and social groups supply the subject matter of ethics. We distinguish between actions that are voluntary—those which we do intentionally—and actions which are involuntary. Ethics studies voluntary actions, those which we carry out with sufficient knowledge and choice. Psychologists and sociologists also examine such actions. The *ethician*, or student of ethics, has a particular interest in the moral character of voluntary actions. He wants to know what makes them right or wrong, and what gives them a definite moral quality.

One of man's special traits is to ask thoughtful questions about what he should or should not do. He does not have to ask about breathing and digesting (involuntary actions), but he does have to ask whether he should accept a bribe or how he should treat his children. Some actions are not determined for him, but fall within his moral choice.

Ethics makes a systematic study of our moral ideals and goals, our motives of choice, and our patterns of good and bad conduct. It remains a science of right living, however, and not in itself a form of moral action or practice. Ethics gives us some general practical knowledge, but we must still make personal decisions which apply this knowledge to particular cases.

Ethics and Morals

The Greek word for *ethics* and the Latin term for *morals*, or *morality*, both come from the same root, the Greek word *ethos*, meaning *custom* or *a habitual mode of conduct*. Yet it is convenient to distinguish between ethics, which refers to the systematic general science of right and wrong conduct, and morals, or morality, which refers to the actual patterns of conduct and the direct working rules of moral action. Without the latter, ethics would be an empty formal abstraction, for ethics bases itself upon a reflective analysis of moral experience.

Need for an Ethical System. Why do we need ethics, in addition to our working morality? The basic reason is that men become curious about their own actions and begin to reflect upon them, compare them, and seek their general principles. In the case of ethical reflection, we encounter certain difficulties. We are not always sure about what moral principle should govern a particular decision. For example, a young person may face the question of whether to continue his education or go to work to help support his family. He may see the problem as one of loyalty to his family. Perhaps he will think that they have sacrificed long enough to keep him in school, and that he owes it to them now to sacrifice something in return. But he may also believe that he owes it to himself to lay a sound basis for a rich life by getting as complete an education as possible. And he may recognize the importance of continuing his education to fit him to make a significant contribution to society.

We may also disagree as to the very meaning of the principle or the virtue in question. And there are moral conflicts between nations and well-meaning individuals. Moral disagreement can sometimes reach back to the basic question of why we should be moral at all, or why we should respect moral obligation. Ethics develops as a way of probing these difficulties and reaching a systematic general doctrine on moral life.

Developing an Ethical System. The ethician develops his science by examining the typical judgments in which men express their moral decisions. Morality consists not only in our particular statements of conduct, but also in the general working rules by which we often justify an individual case. For instance, the conscientious student may say: "I will not write in the margin of this library book." If someone asks him for a reason behind this moral decision, he may reply: "Public property should be respected." Such judgments belong to the moral situation which the ethician studies.

An ethical system is usually the work of some individual thinker, but he must take account of both private and public morality. Serious problems may arise when an ethical system is compared with public morality. The moral philosopher is sometimes highly critical of public morality. Socrates, for example, often disagreed with private citizens and even with the city-state over the meaning of justice and fortitude.

The philosopher must keep two values in mind in developing an ethical system. One is the need for reflection and criticism, particularly in a democracy, where the moral convictions of the public have political importance. The other value concerns the public welfare itself. Circumstances will affect the degree of critical ethical thinking which the community needs and should welcome for a sound public morality.

Ethics and Religion

Ethical reflection has seldom been carried on in isolation from religious convictions. One reason is that religion strongly affects the moral judgments of individuals and communities. The religions of ancient Assyria and Egypt involved definite moral codes regulating conduct and governing decisions in moral matters. The religious commitment extended beyond matters of worship and ritual to include moral precepts.

Judaism developed *ethical monotheism*, the belief in a just God who is the Father of all men and the goal of all our striving for goodness. The conception of a just God enforced man's ethical obligations. The Ten Commandments are the best-known example of how religious belief shaped private and public morality.

Christianity adopted many of the ethical precepts of Judaism. Both Christian and Jewish scholars were concerned with the questions of man's ultimate goal and good and the basis of moral obligation. Christian moralists also developed a natural ethical doctrine based on the Greek virtues of prudence, temperance, courage, and justice. In addition, Christianity stressed the moral qualities of love, mercy, and self-sacrifice as being closely connected with religious values.

Other Religions vary in their emphasis on ethical teachings. Problems of conduct have much more significance for Moslems than for Hindus. Moslems emphasize God's will and the reality of this world. Islam, through the Koran, teaches Moslems certain laws for everyday life. Hinduism, however, stresses the soul's release from this world, and preaches complete detachment from the affairs of this life. The various forms of Buddhism and Confucianism emphasize moral teachings. Both religions have supported the ethical standards of kindliness, temperance, and nonviolence. These religions also encourage personal ethical reflection.

For a list of separate articles in WORLD BOOK on various religions, see Religions of the World in the RELIGION section of the READING AND STUDY GUIDE.

Humanism. Many Western moral philosophers have stressed the development of an independent system of ethics apart from a religious and theological background. This background continues to exert an influence, but many ethicians today want to make ethics a completely independent field. They want to solve ethical problems apart from religious authority. However, the ethical systems they work out may require belief in God, or lead to religion as one of our moral duties. See HUMANISM.

Systems of Ethics

Greek and Roman ethical philosophers included Plato, Aristotle, the Epicureans, and the Stoics. Plato drew an appealing picture of Socrates as the personal model for moral philosophers. He wrote that they should imitate Socrates by seeking their materials in the moral judgments and attitudes of everyday life, and by engaging in persistent questioning until they obtain a definition of the virtuous man. Plato thought that men could regulate the moral life by a personal pursuit of the good, which would lead them beyond material shadows to the ideal forms.

We owe the word *ethics* to Aristotle, who called one of his books the *Nicomachean Ethics* (ethics addressed to Nicomachus). He brought out the ethical significance of the fact that all men seek happiness. This creates the problem of the goal, or real good, in which happiness presents a basic ethical issue. For Aristotle, the highest happiness comes from a contemplative use of the mind. The moral man cultivates the virtues of prudence, temperance, courage, and justice.

During the social unrest of the Hellenistic Age and the Roman Empire, ethics became the most popular part of philosophy. People turned to it for consolation and personal strength. Epicurus and his school centered upon the individual and located the highest good in pleasure (see HEDONIST). Epicureans admitted different kinds of pleasure and praised those of the mind above the pleasures of the body.

The leaders of the Stoic school—Zeno, Seneca, Epictetus, and the Emperor Marcus Aurelius—also advocated unruffled peace of mind. But they found it by uniting the individual with the divine principle of the universe. The Stoics also held that all men belong to the one community of mankind.

Christian theologians have based many of their ethical concepts on the philosophies of St. Augustine and St. Thomas Aquinas. Augustine focused on the relation between man and a personal God as the heart of the moral as well as the religious life. He integrated morality with the Christian love of God and neighbor. Aquinas related the Greek virtues mentioned by Aristotle to the Christian virtues of faith, hope, and charity. He also located the norm for ethical judgment in reason, both as the lawgiving reason of God and as human reason reflecting upon the needs of man's nature.

Later European moral philosophers include Baruch Spinoza, Immanuel Kant, and John Stuart Mill. Spinoza offered a metaphysical type of ethics. He conceived of man as a *finite*, or limited, aspect of the one divine substance of God or Nature. Man must clarify his thoughts and control his passions to the point where he can see his real nature. For Kant, the basic moral issue concerned motivation. An act is genuinely moral only when it is done out of pure respect for duty. If man is a moral agent only when he is free, then he must also be the source of his own moral laws. Mill took a more utilitarian view of the norm of morality. Moral choice should be regulated by the principle of achieving the greatest happiness for the greatest number of people.

In the 1900's, the leading moral theories have been *intuitionism*, *emotivism*, *naturalism*, and *personal realism*. The *intuitionist* position holds that we know the meaning of our basic moral terms and principles immediately. We see them embodied in human moral experience and grasp their significance in an intuitive act. We have to use long reasoning processes in order to reach the moral truth only of secondary and complicated issues. *Emotivism* holds that moral statements express our desires and emotions, but do not convey any knowledge. Moral discourse only states our preferences, but does not justify them. *Naturalism* holds that moral conduct cannot be regulated by any reference to God's will or an afterlife. All moral decisions must be based upon some factual considerations about man as a natural being in the world. We should use the natural and social sciences to help us arrive at decisions which respect human nature. *Personal realism* admits the need to take into account man's position in the rest of nature, but stresses the personal reality of man and his search for God. Both individual and social life must be permeated by man's moral openness to God.

Professional Ethics

The ethics of a certain profession is the code by which it regulates actions and sets standards for its members. The professional code attempts to assure high standards of competence in a given field, strengthen the relationships among its members, and promote the welfare of the whole community. A professional code does not automatically achieve these goals, but does serve to guide and remind people. The code sometimes makes provision for dealing with members who violate the professional ethics of the group. In addition, public laws may regulate a profession in cases where the public interest is at stake.

Some professional codes have a long history. Physicians, lawyers, and ministers of religion have always worked according to careful and exacting standards. One of the best-known codes is the Hippocratic oath, in which the Greek physician Hippocrates pledged the medical profession to the preservation of life and the service of mankind (see MEDICINE [picture, The Oath of Hippocrates]). Today there is a growing trend to maintain by a code of ethics the professional standing and responsibility of engineers, nurses, those in the mass communications field, and other groups with an impact on the community. JAMES COLLINS

See also CONSCIENCE; GOOD AND EVIL; MORAL AND SPIRITUAL VALUES; VALUE (in philosophy); WILL; also PHILOSOPHY with its list of Related Articles.

ETHIOPIA

Waagenaar, Pix

Modern Buildings Line the *Piazza,* or Main Square, in Addis Ababa, the Capital of Ethiopia, *left.* An unusual lion statue constructed of brick, *right,* stands in front of the new municipal theater.

ETHIOPIA, *EE thihOH pih uh,* is an empire on the Red Sea in northeastern Africa. It is one of the world's oldest Christian countries. The name of the country in Amharic, the official language, is YAITYOPYA NIGUSA NAGAST MANGUIST, or IMPERIAL GOVERNMENT OF ETHIOPIA. Ethiopia once was called *Abyssinia.* Addis Ababa is the capital and largest city.

The country covers an area a little smaller than the combined areas of Texas, Oklahoma, and New Mexico. It has about 5,000,000 more people than these three states together. Most Ethiopians are farmers. Their small villages lie on the barren, windswept plains and rugged mountain slopes of Ethiopia's two large plateaus.

The Land and Its Resources

Location, Size, and Surface Features. The northeast coast lies on the Red Sea. The *Map* shows that French Somaliland and Somali lie to the east, Kenya to the south, and Sudan to the west.

The country is flat and dry along the Red Sea coast, in the self-governing state of Eritrea (see ERITREA). But most of Ethiopia lies on two great plateaus that stand above the surrounding desert lowlands. Wall-like cliffs, some more than 2,000 feet high, border the northeastern and western sides of these plateaus. Rolling plains cross some parts. Deep canyons and ravines cut other sections. Mountains rise in the central part of the plateaus. Ethiopia covers 475,800 square miles.

Natural Resources. Ethiopia's fertile soil is its most important natural resource. Minerals include small deposits of iron, gold, platinum, potash, and rock salt.

Climate. Ethiopia's plateaus have an even, mild climate. Temperatures rarely rise above 95°F. or fall below 33°F. The average yearly temperature is 62°F. Rainfall varies from 25 inches to 80 inches a year. The rest of the country is hot and dry.

The People and Their Work

The People. Most Ethiopians are descended from the ancient *Hamites* (see HAMITE). They speak languages

FACTS IN BRIEF

Type of Government: Constitutional monarchy.

Capital: Addis Ababa.

Divisions: Twelve provinces and the federated state of Eritrea. Each province is divided into subprovinces.

Head of State: Emperor.

Parliament: Senate, about 100 senators appointed by emperor for six-year terms. Chamber of Deputies, about 210 deputies, elected for four-year terms.

Area: 475,800 square miles. *Greatest distance:* (north-south) 975 miles; (east-west) 925 miles. *Coast line,* 300 miles.

Elevation: *Highest,* Bejeda (Ras Dashan), 15,158 feet. *Lowest,* sea level.

Population: 18,000,000. *Density,* about 37 persons to the square mile. *Distribution,* rural, 90 per cent; urban, 10 per cent.

Chief Products: *Agriculture,* beeswax, livestock, coffee, cotton, grains, sugar, tobacco, vegetable oil. *Mining,* gold, iron, platinum, potash, rock salt.

Flag: The flag has three horizontal bars, green at the top, yellow in the center, and red at the bottom. See FLAG (color picture, Flags of Africa).

National Holiday: Emperor's Birthday, July 23.

National Anthem: "Ethiopia Hoie" ("O! Ethiopia").

Money: *Basic unit,* Dollar. For its value in U.S. dollars, see MONEY (table, Values).

that are Hamitic and Semitic in origin (see Semite). Other Ethiopian peoples include the Somali, Gurage, Sidamo, Agau, and a Negro group called Shankalla. They speak many languages and dialects. Many Arabs also live in Ethiopia. The official language of the country is Amharic, which belongs to the Semitic family of languages. The ancient language of the country, known as *Geez*, is still used in prayers. Many school children learn to speak English. The name *Ethiopia* comes from Greek, and means *sunburned faces*.

Way of Life. Most Ethiopians are farmers. They live in small villages on the plateaus. A few nomadic herdsmen live in the southeast. The people in the few cities live in houses with white mud walls and sheet-metal roofs. The men wear tight white trousers and shirts covered by a long colored robe. Women wear loose white dresses. A favorite meal consists of meat or chicken curry and flat cakes of millet bread.

Cities. Addis Ababa (pop. 400,000) is the capital of Ethiopia. Other large cities include Asmara (131,000), Hārar (50,000), Dirēdawā (30,000), Gondar (22,000), Massaua (17,000), Decamere (12,900), Akesum (10,000), Dabra-Mārk'os (10,000), and Gorē (10,000).

Agriculture. Coffee is one of Ethiopia's most important farm products. The farmers raise coffee plants on plantations on the plateaus. Other farm products include wheat, vegetable oil, beeswax, sorghum, barley, corn, cotton, sugar cane, and tobacco. Most Ethiopian farmers also raise cattle, sheep, goats, and poultry.

Exports and Imports. Coffee leads Ethiopia's exports. Ethiopia also exports hides, wheat, beeswax, and vegetable oils. Imports include textiles and machinery.

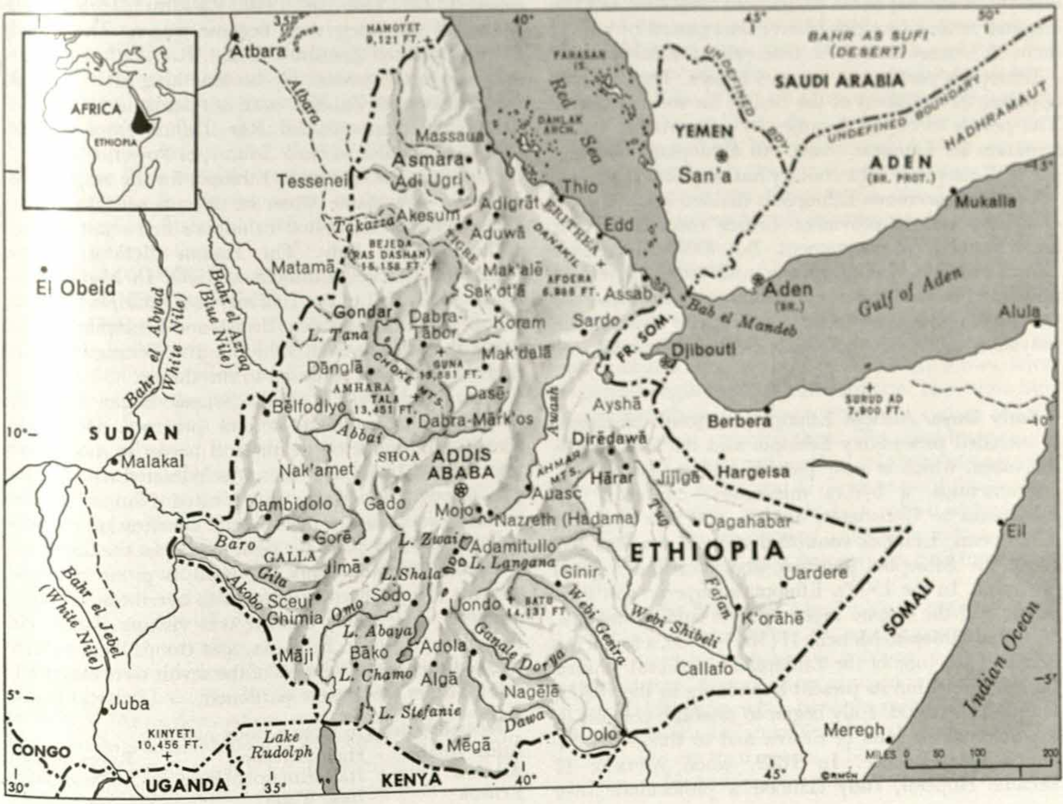
Transportation and Communication. Ethiopia's transportation system has advanced from mules to airplanes since the early 1900's. But railroad construction was almost completely neglected. The country's most important railroad is the 486-mile line between Addis Ababa and the port of Djibouti in French Somaliland. A government-owned airline was started in 1946. Trucks and buses travel over the 4,000 miles of public roads. Camels, donkeys, and mules are used in the remote areas. Telephone and telegraph lines connect the larger cities. Ethiopia has few radio stations.

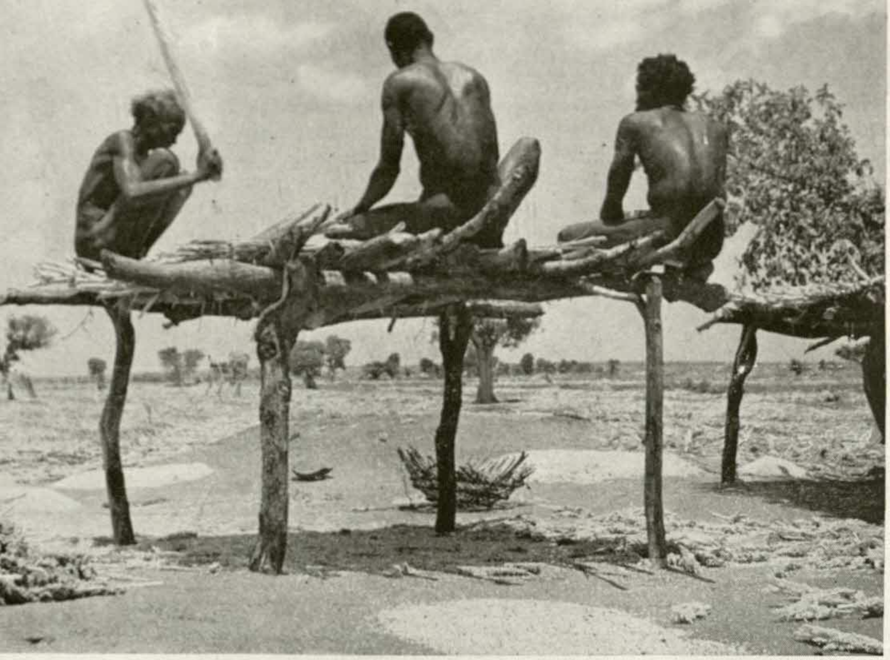
Social and Cultural Achievements

Education. About 80,000 children attend eight-year government-operated primary schools. Another 55,000 go to schools directed by the Coptic (Ethiopian Orthodox) Church. The government also operates some secondary schools and the University College of Addis Ababa. The United States Technical Assistance Program financed the Imperial Ethiopian College of Agriculture and Mechanical Arts in Alemaya. About 90 of every 100 persons in Ethiopia cannot read or write because of a shortage of teachers and classrooms.

Religion. Ethiopia has complete religious freedom. The government recognizes the Coptic Church, a Christian Church related to the Eastern Orthodox Churches, as the official religion (see Copts; Eastern Orthodox Churches). But many Moslems and members of other religious faiths also live in Ethiopia.

The Arts. Ethiopian silversmiths make beautiful





Anuak Tribesmen in western Ethiopia still thresh millet by hand. The seeds fall to the ground when the farmers pound the ripe grain stalks.

United Nations

crosses and other religious objects. The country's artists paint religious or historical subjects in the Byzantine style (see BYZANTINE ART).

Government

National Government. Ethiopia is a constitutional monarchy. The emperor has supreme power in the country. A cabinet and a parliament assist him, but the emperor retains veto power over laws passed by parliament. A woman cannot become ruler of Ethiopia.

Ethiopia's parliament has two houses. The emperor appoints the members of the Senate for six-year terms. The people elect the deputies by proportional representation for four-year terms. All Ethiopians over the age of 21 may vote. The country has no political parties.

Local Government. Ethiopia is divided into the state of Eritrea and 12 provinces. Eritrea controls its own budget and local government. But Ethiopia controls Eritrea's money, foreign affairs, and trade. Governors appointed by the emperor for indefinite terms head the provinces and subprovinces. The emperor appoints the mayors of cities, but the people elect city councils.

History

Early Days. Ancient Ethiopia lay south of Egypt. It included present-day Ethiopia and the area known as Nubia, which is now part of Sudan (see NUBIA).

Frumentius, a Syrian missionary, converted the Ethiopians to Christianity in A.D. 330. For the next 1,300 years, Ethiopia controlled most of the Red Sea coast, the Ethiopian plateaus, and occasionally parts of Arabia. In the 1500's, Ethiopia's emperors lost their power and the empire broke up into small kingdoms.

United Ethiopia. Menelik II (1844-1913), a son of the king of Shoa (one of the Ethiopian kingdoms), unified the empire within its present boundaries in the 1880's. During this period, Italy began to establish colonies in the neighboring land of Eritrea and to threaten Ethiopia's independence. In 1889, when Menelik II became emperor, Italy claimed a protectorate over Ethiopia. Because of this claim, Italy and Ethiopia went to war in 1895. Ethiopia's small army defeated the Italians at the Battle of Aduwa in 1896.

In 1911, Menelik II became ill, and his nephew Lij Yasu (1896-1935) came to the throne. The young emperor was converted to the Islamic religion. But most of his people were Coptic Christians, and they deposed Lij Yasu in 1916. Zauditu (1876-1930), Menelik's daughter, then became queen. The tribal chiefs appointed Zauditu's cousin, Ras Taffari, regent and heir to the throne. He became king in 1928, and was coruler with Zauditu until her death in 1930. The Ethiopians then crowned Ras Taffari emperor. He changed his name to *Haile Selassie*, or Power of Trinity, because it is the custom in Ethiopia for the emperor to choose a new name when he is crowned. In 1931, Haile Selassie established Ethiopia's first constitution.

Conquest by Italy. The Italian dictator Benito Mussolini attacked Ethiopia in 1935. In May, 1936, Addis Ababa fell to the Italians, and Ethiopia became part of Italian East Africa. British and Ethiopian troops drove the Italians from Ethiopia and Eritrea in 1941, and Haile Selassie returned to the throne.

After World War II, Haile Selassie began a social, political, and economic reform program. He made slavery punishable by death, and began to modernize the country. In 1952, Eritrea was federated with Ethiopia through action by the United Nations. Haile Selassie proclaimed a more liberal constitution in 1955 which gave Ethiopians the right to vote for the first time.

Recent Developments. In 1960, a group of high-ranking army officers attempted to overthrow the government while Haile Selassie was visiting Brazil. He returned quickly to Ethiopia, and troops loyal to him crushed the revolt. Leaders of the revolt were executed, but all other rebels were pardoned. WOLF LESLAU

Related Articles in WORLD BOOK include:

Addis Ababa
Asmara
Eritrea
Haile Selassie I
Italo-Ethiopian War
Lake Tana
Races of Man (Negroids; picture)

ETHIOPIAN LILY. See CALLA.

ETHMOID BONE. See HEAD.

ETHNOCENTRISM, *ETH no SEN triz'm*, is a universal belief in the superiority of one's own culture, and a parallel hostility and suspicion toward other cultures (see CULTURE). Most people find it almost impossible to think objectively about culture.

Most societies encourage ethnocentrism by rewarding people loyal to the established customs and punishing nonconformity. JOHN F. CUBER

ETHNOLOGY, *eth NAHL oh jih*, is a branch of the science of anthropology. It deals with the study of human *culture*, of the habits and beliefs of the different peoples of the world. Ethnologists compare cultures to see how they differ from each other, and to discover in what ways they are alike. They try to formulate scientific laws about cultures that will help us to understand why people behave as they do. Ethnology tries to provide answers to such questions as: Can there be any government if there are no courts or policemen? How do cultures change? Can we predict how culture will change as science spreads, and as man moves out into space? MAY EDEL

See also ANTHROPOLOGY (Ethnology); CULTURE.

ETHNOLOGY, BUREAU OF AMERICAN, studies the history and way of life of the American Indians. The bureau also excavates the ruins of ancient villages, mounds, cliff dwellings, and caves, and preserves the materials found there. The bureau publishes illustrated bulletins, and furnishes information about Indians to students, publishers, and other interested groups. John Wesley Powell organized the bureau in 1879 under the control of the Smithsonian Institution (see POWELL, JOHN W.). Critically reviewed by BUREAU OF AMERICAN ETHNOLOGY

ETHYL, *ETH ul*, is a hydrocarbon radical that makes up part of numerous organic chemical compounds. The ethyl radical, or group, consists of two carbon and five hydrogen atoms, C_2H_5. An ethyl group and a hydroxyl (OH) group make up ethyl alcohol. Ethyl is also the trade name for a substance sometimes added to motor fuel to prevent the ringing sound in the internal-combustion engine. It contains chiefly tetraethyllead. See also TETRAETHYLLEAD. GEORGE L. BUSH

ETHYL ALCOHOL. See ALCOHOL.

ETHYL ETHER. See ETHER.

ETHYLENE, *ETH uh leen* (chemical formula, C_2H_4), is a gaseous hydrocarbon. Chemists make it by heating ethyl alcohol with sulfuric acid, or by uniting hydrogen and acetylene in the presence of a catalyst.

Ethylene has been in general use as an anesthetic since 1923, when A. B. Luckhardt and J. B. Carter of the University of Chicago made its value for this purpose known. Some physicians prefer this gas to ether and nitrous oxide (laughing gas). The patient's breathing continues normally under its influence, his muscles remain relaxed, and he suffers no unpleasant aftereffects such as nausea and gas pains. Doctors usually administer it in a mixture of oxygen and 80 to 90 per cent of ethylene. See ANESTHESIA.

Industry uses ethylene to ripen fruit, such as oranges, grapefruit, and bananas. Fruitgrowers pick and ship the green fruit. At its destination, workers place it in rooms that contain a small amount of ethylene. The fruit soon takes on a ripe flavor and color. Ethylene is also used by industry in making poisonous mustard gas. GEORGE L. BUSH

ETIQUETTE, *EHT ih ket*. Have you ever watched two hungry dogs that want the same dish of food? They growl at each other, and perhaps fight. In the end, the larger or louder dog usually takes all the food. Two normally polite persons in the same situation would share the food between them. The difference between the dogs and the people is that the people have been taught to behave according to the rules of etiquette.

What Is Etiquette? Etiquette is simply a set of rules of behavior. By using these rules, people make living with each other more pleasant and comfortable. A man driving down a road on which there are no other cars can drive on either side of the road and at any speed without bothering anybody. But, if there are other cars on the road, he must drive on the right side of the road and at a safe speed. In the same way, a man who lives entirely alone can behave any way he chooses. No one else cares what he does. But a man who lives among other people must behave so that he does not trample on their rights. As a guide for his behavior he has a set of rules that are like traffic rules. These rules are called etiquette.

The word *etiquette* comes from an old French word meaning *ticket*. It later came to mean a *prescribed routine*, especially of court behavior. Charles I and II of England copied the rules of etiquette from the French court. These rules became the requirements of behavior in court circles and among aristocrats everywhere.

Etiquette covers the whole field of human relations. There are rules of behavior for the simplest actions and for the most elaborate of social occasions. Many people think of etiquette as dealing with such questions as how to plan a formal party or a church wedding. But the most important rules of etiquette involve much more common things. When we meet a friend on the street, we say "Hello" or "How do you do." If we have time, we may stop and ask him some question about himself or about some family news to show our interest in him. This is the courteous thing to do. We have similar customs of courtesy for all occasions, especially when entertaining guests.

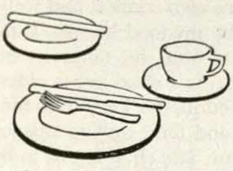
Learning Etiquette. All people are born entirely selfish. A baby cares only about his own comfort and well-being. If he is hungry, he grabs any food he sees. If he sees some object that attracts him, he takes it, no matter what it is or whose it is. As a child grows older, his parents begin to teach him etiquette. They train him to eat properly with a knife and fork, and to ask for things instead of grabbing them. The child learns to be thoughtful of other persons and of their feelings. He learns not to be noisy, and to speak respectfully to older people. In short, he is taught how to live with people according to the recognized rules of conduct. If he learns well, he will always be courteous and have good manners.

Reasons for Etiquette. Most rules of etiquette have good reasons behind them. In some cases the reasons have disappeared, and the rule is now an almost meaningless custom. One of these customs is handshaking. In the Middle Ages, when two men met, they extended their right hands and shook hands to show that they did not intend to use their swords. The handshake served as a display of friendship. It remains a gesture of courtesy

Come to the Dinner Table with clean hands

"Please" and "Thank You" are passwords of courtesy.

Use Knife and Fork to cut large pieces of food



Place Knife and Fork at side of plate

Break Bread before buttering. Chew with mouth closed.

and friendship, and there are many occasions when it is necessary. People always shake hands with a guest of honor. On all formal occasions, the host and hostess must shake hands with strangers, and naturally shake hands with friends. Guests shake hands with the host and hostess when they leave. Children do not shake hands often, but they all do at times.

Most of the rules of etiquette in relations between men and women are based on good reasons. When women wore long, flowing skirts, its was difficult for them to alight from a carriage. Gentlemen helped them. Today, it is polite for a man to stand ready to give his hand to a woman getting out of a car, in case she needs assistance.

Other rules of etiquette are based on what is called *good taste*. There are things we do not do because they would offend other people. Most of our eating manners are based on good taste. We do not shovel food into our mouths, talk with our mouths full, or eat messy food with our fingers. To do so would be unpleasant for other people to watch. We take frequent baths, brush our teeth, and wear clean clothes, both because it is good for our health and because it makes life more pleasant for the people around us.

Formal and Informal Etiquette. Many rules of etiquette are simply *forms* for performing various social acts. These forms vary from country to country, from period to period, and from group to group. Generally, the simpler people's lives are, the simpler are their social customs. Two or three hundred years ago in Europe, the rich nobles who lived at kings' courts enjoyed a highly developed social life. They did no work, so to pass the time, they added to the ceremonies of the court and made more and more rules of etiquette. They developed rules of behavior for every social function. Often there were no particularly good reasons for the rules.

The ways of formal etiquette remain today. These customs include the proper way to conduct weddings, to set silverware and dishes on a table for a formal dinner party, and to send invitations for a social function. These customs vary with different groups. As a rule, wealthy members of what is called "high society" have more complicated and more rigid forms of etiquette than less well-to-do people. The customs of people who live in cities differ from the customs of those who live in small towns. One example is in visiting customs. In formal city society, women usually pay formal calls on newcomers to their social group. They make calls only at certain hours. Sometimes the visitor does not even see the person on whom she is calling. She merely leaves her card. In small towns, women call immediately on new people. They call informally on all newcomers, regardless of their "social standing." People consider such calls neighborly. There is no real difference in etiquette between the two customs. The formal action among the city group is the proper thing to do, but it would be considered snobbish in small towns.

Conversation is one of the most important aspects of human relations. The way we talk to people largely determines the way they feel about us. Polite speech is the surest mark of good manners. Rudeness to those who serve us marks an impolite person. Etiquette provides rules for both what we say and how we say it. An uneducated man may use bad grammar, but the kindness and tact with which he speaks will mark him as a

Introduce Persons who have not met before.

A Boy Walks at the girl's left, or nearest the curb.

Sit Quietly in a movie to avoid disturbing others.

Offer Your Place to older persons who are standing polite man. Another person may use perfect grammar, but make so many unkind remarks that it is obvious he has no manners. A person shows his conversational manner best when arguing. One with bad manners shouts when angry. He often interrupts. A person with good manners keeps his voice low, and lets others continue speaking until they have finished. But this works both ways. Only a bore talks so constantly that no one can speak without interrupting.

Good conversational manners include more than saying "Please" and "Thank you." These phrases are important, but we must also remember the general rule in any conversation: speak to others as you would have them speak to you.

A man may have good table manners, but a rude way of speaking to a waiter will identify him as a man of little training in etiquette. People make others happy or unhappy by the way they speak to them. Their manner of speech often determines how others will treat them.

Differences in Etiquette. There are sharp differences in etiquette among countries. What is polite in one country may be impolite in other countries. Differences exist not only in the more formal rules of etiquette, but sometimes also in the basic rules. For example, people in the United States consider it impolite for a man to walk ahead of a woman. But, in Burma and several other countries, the wife may walk behind her husband as a sign of her submission to him. Ways of living also govern etiquette. In Japan, for instance, people take off their shoes before entering a house. There is a good reason for this. Floors of Japanese houses are made of straw mats, and shoes would damage them.

Etiquette is not simply a matter of civilization. It is true that more civilized nations usually develop more complex rules of etiquette. But even the simplest societies have rules of behavior. Many explorers find it wise to study the rules of etiquette of remote tribes in places they plan to visit. If a person is impolite in ordinary society, people merely consider him rude. If an explorer breaks an important rule of etiquette of a tribe of savages, they may kill him.

Changes in Etiquette. The rules of etiquette change as living conditions change. The early pioneers in America lived a simple, rough life. Their etiquette reflected their way of living. As the United States became more thickly settled and the standard of living rose, social behavior became more formal. New inventions have also brought changes in etiquette and new rules. The use of the automobile has led to a whole set of rules for politeness in driving. Social changes also alter etiquette. As women gained more social freedom, they lost some of the privileges they once had. Men still show a special politeness toward women. Courtesy does not change, and a gentleman always practices it.

Importance of Etiquette. The most important thing about politeness is that it makes living with people much more comfortable. But it also has other values. In business, it pays to be polite. People who are waited on by a polite salesgirl in a store will want to return to that store. A cheerful, courteous switchboard operator will bring business for her firm. Politeness also counts in friendships.

We are polite to each other because we want other people to be polite to us. To be polite sometimes costs us some of our comfort. But, in the long run, we gain more than we lose, because other people show consideration for us. A courteous person will be liked.

Etiquette is much simpler than many persons realize. The association of the word with forms of social behavior has made many people uneasy. They think that if they do not know how to give a formal party, they do not know etiquette. But there are impolite persons who know all the forms of "high society," and do not know how to treat other people with kindness and respect. And some of the most polite people are those who live simple, informal lives. It is important to follow the social customs of the group with which we live. But it is more important to follow the Golden Rule: "Do unto others as you would have them do unto you." In other words, doing as *you* would have *them* do would be very simple. The real requirement of etiquette is to do as *they* would have *you* do.

EMILY POST

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ETNA, in Greek mythology, was the name of the mass of rock under which Zeus buried the fire-breathing monster Typhon. It smoked and burned continually, and was thought by the Greeks to be the workshop of Vulcan and of the one-eyed Cyclopes.

PADRAIC COLUM

ETNA, MOUNT. See MOUNT ETNA.

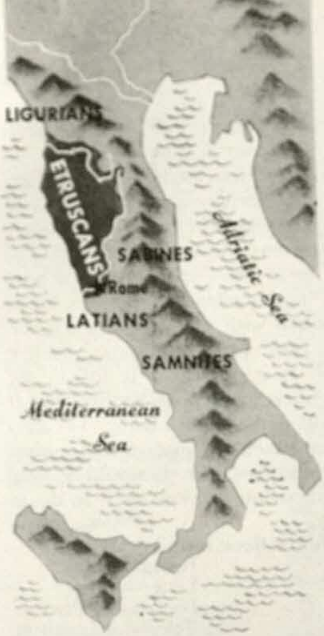
ETON COLLEGE, *EE t'n*, is the largest and most famous of English "public," or tuition, schools. It has more than 1,000 students, all boys. The school was founded in 1440 by Henry VI as "King's College of Our Lady of Eton beside Windsor." The original object of the college was to educate 25 poor boys and support 25 poor men. Tuition pupils have been admitted since 1443. Many of England's famous statesmen and soldiers have been educated at Eton. See also ENGLAND (picture, Eton College).

R. W. MORRIS

ETOWAH MOUNDS. See GEORGIA (Interesting Places to Visit).

ETRURIA. See ETRUSCAN.

ETRUSCAN



The Etruscans ruled the hilly area in central Italy called Tuscany.

An Etruscan Goddess in bronze greatly resembles Greek sculpture.

Fogg Art Museum, Harvard University, Cambridge, Mass.

The Stone Bust of a Woman found in Etruria, *left,* is painted red, yellow, and blue. An overall geometric design in red covers the sides of an Etruscan earthen vessel, *above.*

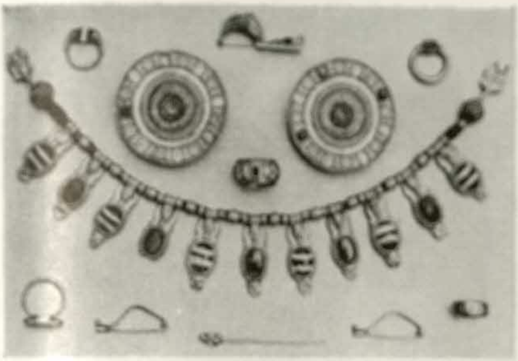
Chicago Natural History Museum

ETRUSCAN is a person who belonged to a group of people who lived in Etruria (modern Tuscany), a part of the Italian peninsula. The boundaries of Etruria include the Arno River in the north, the Tiber River in the south, the Apennine Mountains in the east, and the Tyrrhenian Sea in the west. Most scholars today accept the ancient tradition that the Etruscans came from the east and colonized Etruria shortly after the Trojan War (1100's or 1000's B.C.).

Once established in Etruria, the Etruscans reduced the native Umbrians to a status of near slavery. The Etruscans spread north across the Apennines into the Po valley and south across the Tiber into Latium and Campania. Their civilization in the Po Valley reached its height in the 400's B.C. It centered around Felsina (the modern Bologna). Their control in Latium (including Rome) seems to have lasted throughout the 500's B.C., and in Campania for 60 or 70 years longer. The Gauls broke their hold on the Po Valley shortly

Bronze Relief Decorated the Side of an Etruscan Chariot.

Metropolitan Museum of Art



Metropolitan Museum of Art

Etruscan Jewelry fashioned about 500 B.C. is made of gold and set with semiprecious stones. Craftsmen used designs of heads of women, satyrs, gods, and other objects on the ornaments.

after 400 B.C. Etruria itself passed wholly under the control of Rome early in the 200's B.C.

Influence on Rome. The historical importance of the Etruscans lies in their influence upon early Rome. Theirs was the first well-developed city culture with which the small farming communities in ancient Latium came into contact. Etruscan kings ruled Rome during the 500's B.C., when Rome itself grew from a village into a city. The public works which the Etruscans built or began during this time placed Rome in a position from which, after the last Etruscan king had been driven out, it could rule over most of Latium.

Language and Culture. The culture of the Etruscans was to a great extent their own, although in certain fields they borrowed heavily from the Greeks. This culture probably began in Asia Minor, perhaps in Lydia, and was part of the group of pre-Greek cultures which flourished in Anatolia and the Aegean area before 1000 B.C. The Etruscans' alphabet came from the Greek, but their language cannot yet be translated. Recent studies seem to show a relationship between the Etruscan language and little-known Anatolian tongues, especially the Lydian. It is certain that Etruscan is not related to Latin or to any of the Italic languages, and is not a member of the Indo-European family of languages. Etruscan priests, or *haruspices*, were famous in ancient times for their care in religious ritual and reading of the future. In this respect, above all others, they influenced the Romans. The Roman gladiatorial show also came from Etruria.

The wealth of the ancient Etruscans came partly from manufacturing and mining, but more from their early control of shipping in the western Mediterranean. It was natural that this wealth should encourage a taste for luxury, which the Romans thought decadent.

Government. In general, scholars no longer advance the theory that the Romans borrowed their political institutions, such as the magistracies, from the Etruscans. The use of a borrowed word *(lictor)* or symbol *(fasces)* does not of itself suggest the loan of an institution. But the influence of Etruria upon early Rome was strong and continuous.

The political unit of the Etruscans was the city, of which there were 12 in Etruria proper. A small aristocratic ruling class governed each city, sometimes through a king, more often through a magistracy. The cities themselves were joined in a common federation or league. Like the Greek leagues, it was not strong enough to prevent war between the cities, or even to insure unity in the face of danger. With the Roman conquest of southern Etruria (405-396 B.C.), the league virtually ceased to function. WILLIAM F. MCDONALD

See also ARCHITECTURE (Roman); HORATIUS (picture).

ETS, MARIE HALL (1895-), author and illustrator of children's books, won the 1960 Caldecott medal for her illustrations in *Nine Days to Christmas*. She also wrote and illustrated *Mister Penny* (1935), *Oley, The Sea Monster* (1947), and *Play With Me* (1955). Mrs. Ets was born in North Greenfield, Wis.

ÉTUDE, *AY tyood*, is a piece of music written especially to enable students to practice some particular point of technique. Its purpose may be to strengthen certain fingers, to improve rhythm or accent, or to develop musical style. The word *étude* is French and means *a study*. Études are also written as compositions to be played for their own beauty. The Chopin, Czerny, and Clementi études for piano, and the Mazas and Kreutzer études for violin, are examples. CHARLES B. RIGHTER

ETYMOLOGY, *EHT uh MAHL oh jih*, is the study of the history and development of words. It is concerned with the origins of words, their relations to similar words in other languages (called *cognates*), and the way their meanings have changed through the years.

Every word began with a certain form and a certain meaning. But when enough people wanted a given word to have another meaning, it would change.

Etymology helps give a fuller and clearer understanding of what a word means. It also helps us understand what long and difficult words mean. For instance, the word *recalcitrant* comes from two Latin words, *re*, meaning *back* or *backward*, and *calx*, meaning *hoof*. In Latin, these two were put together into *recalcitrare*, which means *to kick back*. The dictionary defines a recalcitrant person as being "stubbornly rebellious." But the picture of an angry mule kicking backward against a wagon emerges when the word is examined etymologically. It becomes much more vivid than before.

Cognates are words that descend from a common ancestor, for example, *chase* and *catch*, which came from the Latin word *captare*. Most of the languages of Europe are related to English. They make up what is called the *Indo-European* family of languages. The word *mother* comes from the Anglo-Saxon *modor*. It is closely related, or cognate, to the German *mutter*, the Swedish and Danish *moder*, the Latin *mater* (from which came the French *mère* and the Italian *madre*), the old Irish *mathir*, the Sanskrit *matr*, and many others among this family of languages.

The Study of English Words goes hand in hand with the study of English history. Each invasion of England brought new words into the language. The Saxons provided the foundation of the English language. French, Romans, and Danes left many of their own words in the English language. For example, the Latin word for a fortified camp is *castra*. The Romans ruled England for about 500 years. During that time, the people of England got into the habit of adding the word *castra* to a root word in order to give the fortified Roman camps a name. They thus produced names like *Lancaster* and

Manchester. The Danish word for *town* was *by*, and many English towns have names such as *Whitby* and *Derby*. Another Danish word, *tun*, appears in names like Boston. The Old French word for beef was *boef*, and the modern French is *boeuf*. This word went across the English channel and became the modern English *beef*. But a favorite food of the English was roast beef, and the French also became fond of it. They adopted a new form and spelling of the word—*rosbif*.

Many words have changed their original meaning in peculiar ways. *Depart* used to mean *separate*, or *divide*. The old English marriage service once read "till death do us depart." A *jig* was once a fiddle to whose music the country folk danced. *Imp* used to mean *a young shoot of a plant*. Then it came to mean *child*, and prayers offered for the health of the Prince of Wales once referred to him as "that most angelic imp." The word *cab* is a short form of *cabriolet*, which originally meant a leap or caper like that of a wild goat. JAMES R. HULBERT

See also DICTIONARY; PHILOLOGY.

ETZEL. See NIBELUNGENLIED.

EUBOEA, *yoo BE ah*, or **EVVOIA** (pop. 164,542), is the largest of Greece's islands in the Aegean Sea. It covers about 1,586 square miles Euboea lies just east of the lower mainland of Greece. For location, see GREECE (color map). Deep, fertile valleys with farms and orchards cut through the island's four mountain ranges. Mount Delphi, the highest peak, rises 5,725 feet above sea level.

The name *Euboea* means *rich in cattle*, and cattle raising has been an important industry on the island for hundreds of years. The chief agricultural products are olive oil, wheat, fruit, and honey. Mineral deposits include iron, lead, and magnesite. The most important towns are Khalkis (Chalcis), the capital, and Karistos (Carystus).

Euboea has been occupied by the Ionians, Athenians, Macedonians, Romans, Venetians, and Turks. It became part of Greece in 1830 as a result of the Greek war for independence. HARRY N. HOWARD

EUCALYPTUS, *yoo kuh LIP tus*, is the name of a group of large trees native to Australia and Tasmania. These trees are useful for their oil, gum, and timber. Although a few varieties grow in cold and mountainous regions, most eucalypti grow best in warm climates and in moist places. They have been successfully grown in Florida, irrigated sections of southern California, and other parts of southern United States. The eucalyptus most planted in America is the *blue gum*. The trees grow rapidly and reach a gigantic size. The leaves are long, narrow, and leathery. The flowers look like bells, and are filled with nectar.

In Australia, the eucalyptus is the most important timber tree. The *jarrah* is an Australian eucalyptus with red wood much like mahogany. In California, eucalypti are planted around orange and lemon groves to break the force of the wind. Manufacturers use eucalyptus lumber for ships, railroad ties, paving blocks, telegraph poles, fences, and piers. The trees furnish a resin, called *Botany Bay kino*, which protects wood against shipworms and other borers. The bark of some species furnishes tannin, which is used in medicine. Eucalyptus leaves contain a valuable oil that smells somewhat like camphor. Oil of eucalyptus is used as an antiseptic, a deodorant, and a stimulant.

Josef Muench

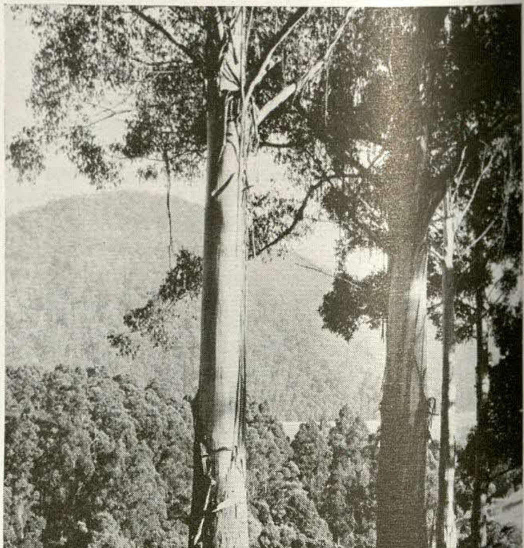
Eucalyptus Flowers blossom from hard-shelled white buds. The lance-shaped leaves are protected from the heat because they grow with their edges toward the hot tropical sun.

Scientific Classification. Eucalyptus trees belong to the myrtle family, *Myrtaceae*. They make up the genus *Eucalyptus*. The blue gum is *E. globulus*. The jarrah is *E. marginata*. HAROLD NORMAN MOLDENKE

See also GUM TREE; SWEET GUM TREE.

Eucalyptus Trees grow rapidly and sometimes reach a height of 300 feet. Trees are cut for fuel when they are from 4 to 6 years old. After 20 to 30 years, they can be cut for timber.

Australian News and Info. Bur.



EUCHARIST. See COMMUNION; TRANSUBSTANTIATION.

EUCHARISTIC, *yoo kuh RIHS tick*, **CONGRESS** is an assembly of Catholics from all countries to promote the religious way of life and to protest against the *secular*, or worldly, way of life. Public processions are held in honor of The Blessed Sacrament, and all who take part in The Congress receive Communion. Methods of increasing devotion to the Eucharist are presented through discussion. The Congress is attended by both clerics and laymen. It was first held at Lille, France, in 1881, and has since been held at intervals in various cities. The last international Eucharistic Congress took place at Rio de Janeiro in 1955. The last one held in the United States was at St. Paul and Minneapolis, Minn., in 1941. Fulton J. Sheen

EUCKEN, *OI kun,* **RUDOLF** (1846-1926), a German philosopher, won the 1908 Nobel prize for literature for *The Meaning and Value of Life*. He also wrote *The Problem of Human Life as Viewed by the Great Thinkers from Plato to the Present* (1890). Both books were widely translated. Eucken combined some of the ideas of Plato and J. G. Fichte, the German philosopher. He was born in Aurich. Walter Kaufmann

EUCLID, *YOO klihd,* Ohio (pop. 62,998; alt. 650 ft.), is a residential and industrial suburb of Cleveland. Euclid lies about 10 miles northeast of the metropolitan business district, and covers several miles of the Lake Erie shore. For location, see Ohio (color map).

Industrial plants in Euclid manufacture electrical appliances, office machinery, road machinery, brass and copper goods, and other metal products. Building zoning was first ruled as constitutional by the Supreme Court of the United States as a result of a case in Euclid in 1926.

Euclid was settled in 1797 by a group under the leadership of Moses Cleaveland. It was incorporated as Euclid Township in 1809, and as a city in 1930. It has a mayor-council government. James H. Rodabaugh

EUCLID OF ALEXANDRIA, *YOO klihd,* a Greek mathematician, is often called "The Father of Geometry." His book on elementary geometry, written more than 2,200 years ago, was used as a textbook in schools until about 1903. *The Elements*, his most famous work, consisted of 13 books. Its most important feature was the logical organization of what had been known earlier about geometry. *The Elements* also contained chapters on geometrical algebra and number theory. Euclid proved the number of *primes*, numbers which are divisible only by themselves and one, to be infinite. There were many translations of Euclid's *Elements*. He also wrote books on such subjects as optics and conic sections, but most of them were lost. See Geometry.

Little is known about Euclid's life. The place of his birth is uncertain. According to Proclus, a Greek philosopher who wrote about him 700 years after Euclid's death, Euclid lived during the reign of Ptolemy I (see Ptolemy [I]). Euclid founded the first school of mathematics in Alexandria. According to Proclus, the king asked Euclid if there were not an easier way to learn geometry than by studying *The Elements*. Euclid answered the king's question by saying, "There is no royal road to geometry." Phillip S. Jones

Culver

Euclid of Alexandria

EUDOXUS OF CNIDUS. See Mathematics (The Greeks).

EUGENE, *yoo JEEN,* Ore. (pop. 50,977; alt. 422 ft.), is the center of a rich agricultural and lumbering area in western Oregon. It lies at the head of the rich Willamette Valley, 120 miles south of Portland. For location, see Oregon (color map).

Eugene ranks as the third largest city in the state. The manufacture of forest products and the processing of agricultural products are its chief industries. Eugene is the home of the University of Oregon and Northwest Christian College. It has more than 20 public schools, about 20 municipal parks, and a public library.

Eugene developed from a village named for Eugene Skinner, who settled there in the 1840's. The city was incorporated in 1862. Eugene grew rapidly after the arrival of the railroad in 1870.

The seat of Lane County, Eugene has a council-manager form of government. Richard M. Highsmith, Jr.

EUGENICS, *yoo JEN ihks,* is concerned with applying principles of heredity to improve the human race. Eugenics can be thought of as both a science and a social movement. The word itself comes from a Greek word meaning *good birth*. Eugenics proposes to improve future generations by increasing the number of children produced by persons of superior types. It would reduce the number of children from parents who are physically or mentally deficient. Attempts to encourage larger families from superior parents are called *positive eugenics*. Attempts to reduce the number of children from defective parents are known as *negative eugenics*.

Unfortunately, knowledge of human inheritance is not great enough to be sure what kind of children parents will have. Superior parents do not always have superior children. Although the parents show no undesirable traits, they may carry undesirable traits, and transmit them to future generations. Also, mentally deficient parents do not necessarily produce mentally deficient children. Geneticists have concluded that even rigorous control over marriages and the number of children would change the well-being of the race so slowly that even slight change would take many generations.

Eugenics began with the researches of Sir Francis Galton in the 1880's, but it has not won complete acceptance. It has often been opposed on religious grounds. Many persons also believe that eugenics takes away certain basic human rights, such as a person's right to marry the mate that he has chosen.

Some authorities, however, have advocated laws that prevent defective persons from having children, and some states actually have such laws. Also, there is much public support for educational programs and for voluntary eugenic action. Some medical schools have heredity clinics to advise parents on the possibility of their children inheriting diseases or defects.

The improvement of the human race depends not only on heredity, but on an improved environment. Improvement of the race by changing the environment is called *euthenics*. James F. Crow

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EUGÉNIE, *YU ZHAY NEE,* **MARIE DE MONTIJO** (1826-1920), became Empress of France as the wife of Napoleon III (see NAPOLEON III). She married Napoleon in 1853, soon after the Second Empire was proclaimed. While she gave beauty and charm to the reign, she became noted for extravagance. She strongly favored the Roman Catholic and conservative group, and tried to delay a more liberal government. She urged a warlike policy on the eve of the Franco-Prussian War (see FRANCO-PRUSSIAN WAR). After 1870, she was forced to live in exile. She was born in Granada, Spain. E. J. KNAPTON

Chicago Historical Society

Empress Eugénie

EUGENIUS, or **EUGENE,** is the name of four popes of the Roman Catholic Church. Their reigns were:

Eugenius I, Saint	(654-657)
Eugenius II	(824-827)
Eugenius III	(1145-1153)
Eugenius IV	(1431-1447)

Saint Eugenius I was noted for his gentleness, sanctity, and generosity. He consecrated 21 bishops.

Eugenius II worked with the Franks and reached an agreement with them on papal elections, status of church property, and conduct of trials.

Eugenius III encouraged the Second Crusade (see CRUSADES). He reigned during troubled times.

Eugenius IV ruled during the Council of Basel (1431-1445), when it was held that the rules of the council were superior to those of the pope. Eugenius was a native of Venice. THOMAS P. NEILL and FULTON J. SHEEN

EUGLENA. See PROTOZOAN (Flagellates).

EULENSPIEGEL, *OI lun SHPEE gul,* **TILL,** was a German prankster who is believed to have lived between 1300 and 1350. Many stories have been told about wild, whimsical jokes and clownish pranks Till played on city people and nobles.

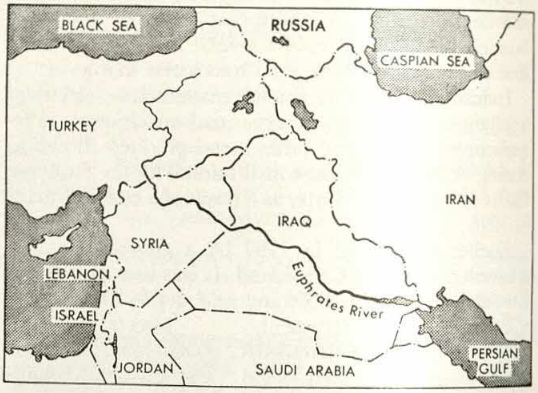
An account of his antics appeared in Low Saxon in 1483. It was printed in High German after 1500 in an inexpensive type of book called a *chapbook*. The book was translated into English, Czech, Polish, Danish, French, and Latin. The title of the early English translation was *Howle-Glass*. In 1867, Charles de Coster, a Flemish writer, wrote an epic *Ulenspiegel*, in which Till is a hero in The Netherlands' fight for freedom against King Philip II of Spain. Richard Strauss, a German composer, wrote a well-known symphonic poem, *Till Eulenspiegel's Merry Pranks*. G. F. MERKEL

EULER, *OY ler,* **LEONHARD** (1707-1783), a Swiss mathematician, became famous for his great output of original mathematics, and for the wide range of subjects he covered. He did much of his work after he became blind in one eye in 1735 and totally blind in 1766.

Euler contributed new ideas in calculus, geometry, algebra, number theory, and probability. He also worked in many areas of applied mathematics, such as acoustics, optics, mechanics, astronomy, artillery, navigation, statistics, and the mathematics of finance and investment. A Swiss scientific society started to publish his complete works in 1909. After more than 50 years, 47 large volumes were published, and the project was still not completed. Euler was born in Basel, Switzerland. PHILLIP S. JONES

EUPHEMISM, *YOU fee miz'm,* is a manner of substituting words of mild meaning for stronger ones that may be offensive. The word *euphemism* comes from a Greek word meaning *to speak well.* Instead of saying that a person *died*, a speaker may use a euphemism and say that he *passed on* or *went to his rest.* To avoid using the word *devil*, people have said instead *Old Nick, Old Harry,* or *the Old Boy.* Euphemisms have added new meanings to words by using mild, positive terms to mean strong negatives. For example, one person accusing another of lying may say that he has an *active imagination.* JOSEPHINE MILES

EUPHORBIACEAE. See SPURGE FAMILY.



The Euphrates River Flows into the Persian Gulf.

EUPHRATES RIVER, *yoo FRAY teez,* is one of the longest rivers in western Asia. The Euphrates rises in the mountains of Turkey and flows more than 1,700 miles to the Persian Gulf. The river runs southeast through the great plains of Syria and Iraq. The Euphrates has changed its course several times over the years. Today, the Euphrates and Tigris rivers join at Al Qurna, Iraq, about 120 miles from the Persian Gulf, to form a single river called the *Shatt al Arab.*

The upper part of the Euphrates is not navigable. The river flows between rocky cliffs as far as Hit, Iraq. Then it flows through a broad valley which produces the finest date crop in the world. Near Ramādī, Iraq, there is a large flood-control project. The Khabur, in eastern Syria, is the most important tributary of the Euphrates.

Southern Iraq, called Lower Mesopotamia in Greek and Roman times, was the center of one of the world's oldest civilizations. Ur, Nippur, and other Sumerian city-states, as well as Babylon and Kish, all stood in the lower Euphrates valley. In the A.D. 600's, the holy Moslem cities of Karbala and An Najaf were founded just west of the Euphrates. CHRISTINA PHELPS HARRIS

See also RIVER (color picture, Longest Rivers).

EUPHROSYNE. See GRACES.

EUPHUISM and **EUPHUES.** See NOVEL-(Early Beginnings).

EURASIA. See EUROPE (Location and Size).

EURATOM, or **EUROPEAN ATOMIC ENERGY COMMUNITY,** is an organization that pools the atomic-energy knowledge, research, and resources of six countries. These countries are Belgium, France, Italy, Luxembourg, The Netherlands, and West Germany. They operate a joint research center that concentrates on adapting atomic energy for peaceful uses. Such power is needed because of declining coal supplies and uncertainty about the availability of oil. The members of Euratom are the same countries that established the European Coal and Steel Community in 1952 to promote coal and steel development (see European Coal and Steel Community). Euratom began operating on Jan. 1, 1958. It has headquarters in Paris.

EURIPIDES, *yoo RIP uh deez* (about 480-406 B.C.), was the third of the three great writers of Greek tragedy. He dealt with the same mythological heroes as the other two, Aeschylus and Sophocles. But he showed the heroes as ordinary Athenians and used his plays to criticize political, social, and religious ideas of the time. He used much simpler language than the earlier playwrights, and his plots were more complicated. His ideas were not always the accepted ones, however, and he sometimes offended writers and politicians of his time. Aristophanes satirized him in several comedies (see Aristophanes). But since Euripides' death, his plays have been revived more frequently than those of his rivals, and more of them have survived.

Of the 90 or so plays that he wrote, 18 tragedies and one *satyr play* (a type of comedy presented at the conclusion of a trilogy) survive. The satyr play is named *Cyclops;* the tragedies are *Alcestis*, *Medea*, *The Children of Heracles*, *Hippolytus*, *Andromache*, *Hecuba*, *The Suppliants*, *Heracles*, *The Trojan Women*, *Electra*, *Iphigenia in Tauris*, *Helena*, *The Phoenician Women*, *Orestes*, *Ion*, *Bacchae*, *Iphigenia in Aulis*, and *Rhesus*. A number of these tragedies have served as models for later playwrights.

Euripides

Visual Education Service

When he was about 70, Euripides left Athens at the request of King Archelaus of Macedonia. He wrote his last two plays, *Bacchae* and *Iphigenia in Aulis*, in Macedonia. At Euripides' death, his rival Sophocles had the actors wear mourning dress in a play he was presenting. MOSES HADAS

See also Greek Literature (Drama).

EUROMARKET, or **EUROPEAN COMMON MARKET,** is a trade alliance of Belgium, France, Italy, Luxembourg, The Netherlands, and West Germany. It is also known as the European Economic Community. Euromarket seeks to create a common market in order to remove all trade barriers on the circulation of goods, manpower, and capital among the six member nations. The members agree to work together toward progressive reduction of tariff rates until they abolish all trade restrictions. They also agree to adopt a uniform policy on tariff rates for nations outside the organization.

The European Investment Bank of Euromarket makes loans to member nations. The organization has arranged for citizens of member nations to travel to one another's countries without passports. It has pooled freight cars that use the tracks of each member nation. It has agreed to set up an integrated control system for air navigation.

Euromarket began operating on Jan. 1, 1958. Its members selected Walter Hallstein, Secretary of State for Foreign Affairs of West Germany, as the first director of the organization. Euromarket has headquarters in Brussels, Belgium.

See also Customs Union.

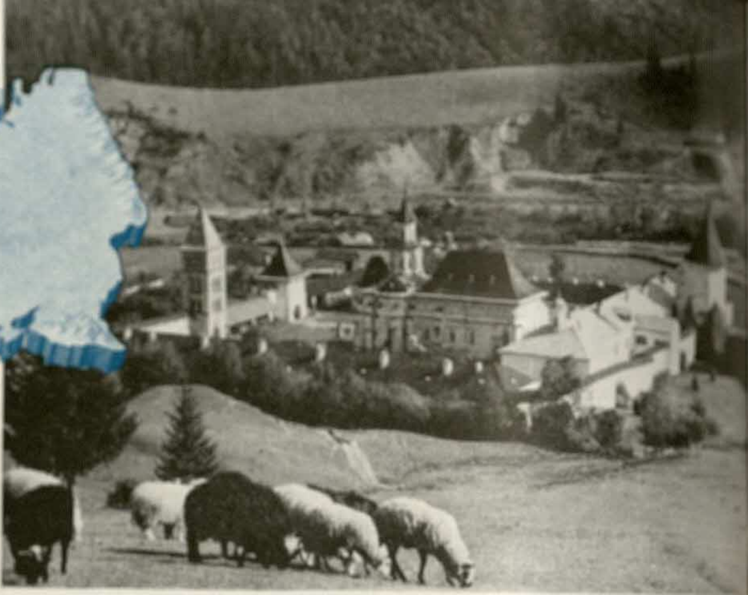
EUROPA, *yoo ROH puh*, was the daughter of Agenor, king of Phoenicia. According to the Greek legend, Zeus (Jupiter) fell in love with her. He changed himself into a beautiful white bull and mingled with her father's herds. Europa was so charmed with the bull's gentleness that she climbed on his back. Zeus at once dashed into the sea and swam with her to Crete. There she bore him three sons.

Later she became the wife of Asterius, king of Crete. Dowden, de Vere, and Landor have written poems about Europa. There are famous paintings of her by Veronese and Titian. VAN JOHNSON

See also Jupiter (god).

Zeus in the Form of a Bull Carried Off Europa.

Drawing by Steele Savage. From *Mythology* by Edith Hamilton, published 1942 by Little, Brown & Co.



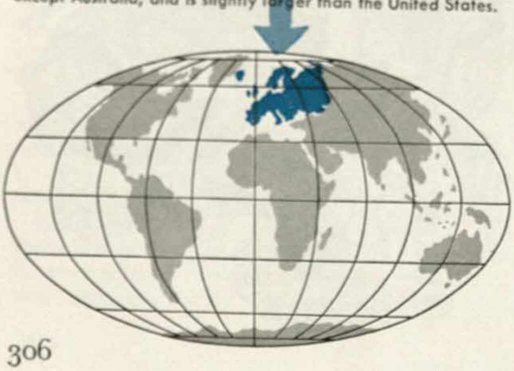
Sanders, Black Star

EUROPE

EUROPE, *YOOR uhp*, is the birthplace of Western civilization. No other continent has had so much influence on world history. From the time of the ancient Greeks, European culture, political ideas, and scientific discoveries have spread to almost every nation. The people who settled the United States, Canada, New Zealand, Australia, and the countries of Latin America came from Europe. Wars between European nations have led to conflicts that raged around the world.

The towering, snow-covered Alps, the colorful tulip fields of The Netherlands, and the white beaches of the French Riviera are among the attractions that make Europe one of the most beautiful regions in the world. Sheep and cattle graze on the quiet English countryside. Wine grapes ripen in the fragrant vineyards of France, Italy, Spain, and Germany. Hardy fishermen sail from picturesque fishing villages that hug the rugged coasts of Scotland and Norway. The beautiful Danube River flows through fertile green farm land from the Black Forest of Germany to the Black Sea. The historic Rhine River winds past steep cliffs dotted with the ruins of ancient castles. London, rich in history, serves as the center of trade and business for the British Commonwealth of Nations. The beauty and cultural landmarks of Paris have helped make it one of the best-loved cities in the world.

Europe (shown in color) covers less area than any other continent except Australia, and is slightly larger than the United States.



Europe includes 33 countries. They range in size from Russia to Vatican City, the smallest country in the world. The climate varies from sunny Spain to the Arctic cold of northern Russia. Most of Europe has rich soil and many mineral resources that help provide a high standard of living for the people. Europe ranks second only to the United States as the most important manufacturing region in the world.

Although Europe covers a smaller area than any other continent except Australia, it ranks second only to Asia in population. About one of every five persons in the world lives in crowded Europe. More than twice as many people live in Europe as live in North America.

The Land and Its Resources

Location and Size. Europe is really a great peninsula joined to the western part of Asia. People sometimes think of Europe and Asia as a single continent called *Eurasia*. Geographers do not agree as to where Europe ends and Asia begins. But a line drawn north from the Caspian Sea through the Ural Mountains to the Arctic Ocean is usually considered Europe's eastern boundary. The Caucasus Mountains, the Black Sea, the Bosporus, the Sea of Marmara, and the Dardanelles form the southern boundary between Europe and Asia. The *Color Map* shows that Europe faces the Mediterranean Sea on the south, the Atlantic Ocean on the west, and the Arctic Ocean on the north.

FACTS IN BRIEF

Area: 3,850,000 square miles. *Greatest length*, 4,000 miles. *Greatest width*, 3,000 miles. *Coast line*, 20,000 miles.

Population: 573,352,600. *Density*, 149 persons to the square mile. *Countries*, 33.

Physical Features: *Elevation*, highest, Mount Elbrus, 18,468 feet; lowest, Caspian Sea, 92 feet below sea level. *Chief mountain ranges*, Alps, Apennines, Balkans, Caucasus, Carpathians, Pyrenees. *Chief rivers*, Danube, Dnepr, Don, Elbe, Rhine, Rhône, Seine, Thames, Vistula, Volga. *Chief lakes*, Caspian Sea, Ladoga. *Chief islands*, Balearic, British Isles, Corsica, Crete, Iceland, Malta, Novaya Zemlya, Sardinia, Sicily, Spitsbergen.

Rugged Mountains cover large areas of Europe. This monastery lies in the Carpathian Mountains of Romania.

←

→

Europe's Long Coast Line has some of the world's best harbors. The statue of the *Little Mermaid*, a character in a Hans Christian Andersen fairy tale, sits on the shore of the busy harbor of Copenhagen, Denmark.

[illegible]

The chief islands of Europe include the British Isles and Iceland in the Atlantic Ocean, Spitsbergen and Novaya Zemlya in the Arctic Ocean, and the Balearic Islands, Corsica, Sardinia, Sicily, Malta, and Crete in the Mediterranean Sea.

Land Regions. Europe has three main land regions: (1) the Northwest Highlands, (2) the Central Lowlands, and (3) the Alpine Mountain System.

The Northwest Highlands, a region of plateaus, rugged mountains, and highlands, stretches from northern Finland through Norway and Sweden. The region also includes northern England, Wales, and Iceland. The highest peak in the region, Galdhöppingen, rises 8,400 feet above sea level in southern Norway. The rugged countryside and thin soil make the Northwest Highlands a difficult area to farm. As a result, many of the people of the region make their living on the sea as fishermen and sailors.

The Central Lowlands, sometimes called the Great European Plain, extend from southeast England and the Atlantic Coast of France to Asia. This fertile, rolling region includes northern France, Belgium, The Netherlands, northern Germany, Poland, and the European part of Russia. In Russia, the Central Lowlands extend from the Arctic Ocean to the Black Sea. Most of the people of Europe live on the Central Lowlands. Farmers reap rich harvests throughout this region, one of the most productive areas in the world.

The Central Lowlands have long served as a natural highway for European armies. Napoleon met his downfall at the Battle of Waterloo in Belgium. Most of the European battles of World War I and many of World War II were fought in Belgium and northern France.

The Alpine Mountain System forms a great wall across southern Europe from west to east. It covers about 800,000 square miles in Spain, France, Switzerland, Italy, Germany, Austria, Czechoslovakia, Hungary, Romania, Yugoslavia, Bulgaria, Albania, Greece, and Russia. The Alpine Mountain System includes five mountain ranges: the Pyrenees, the Alps, the Apennines, the Carpathians, and the Balkans. Some geographers include the Caucasus Mountains in this group.

[illegible]

Europe's Picturesque Windmills provide power in The Netherlands and other parts of the continent. A large part of The Netherlands lies on land reclaimed from the sea.

The steep, rugged Pyrenees form a land barrier between Spain and France. The snow-capped Alps challenge the skill of skiers and mountain climbers. The Alps include such famous peaks as the Jungfrau, the Matterhorn, and Mont Blanc. Passes through the Alps have long served as routes for armies invading Italy from the north. Hannibal, Charlemagne, Napoleon I, and other conquerors led their troops through these mountains. The Apennines rise along the entire length of the Italian peninsula. The most famous peak in this range is Vesuvius, the only active volcano on the European mainland. The eruptions of this mighty mountain have killed thousands of persons and buried

Pompeii and other ancient cities. The Carpathians rise in a half-circle 900 miles long that curves between Romania and eastern Czechoslovakia. The Balkan Mountains form the border between Yugoslavia and Bulgaria, and extend south into Albania and Greece, and east to the Black Sea. Elbrus, Europe's highest mountain, rises 18,468 feet in the Caucasus Mountains.

Several lowland areas lie within the Alpine Mountain System. They include the Po Valley of northern Italy and the plains of Hungary and Romania.

Coast Line. Gulfs, bays, and river mouths cut into the 20,000-mile-long coast line of Europe. Islands and peninsulas form many seas as parts of the Atlantic Ocean, Arctic Ocean, and Mediterranean Sea. For example, the Adriatic Sea is the part of the Mediterranean Sea that lies between the Italian peninsula and the coasts of Yugoslavia and Albania. Other seas that lie off the European coast include the Barents, Kara, Baltic, North, Tyrrhenian, Adriatic, Ionian, Aegean, and Black. *Fiords*, or long, narrow inlets of the sea, cut into the rugged coast lines of several countries, including Norway and Iceland.

Rivers, Waterfalls, and Lakes. The rivers of Europe serve as major means of transportation, provide water for irrigation, and generate hydroelectric power. The mighty Volga River, the longest river in Europe, winds 2,290 miles through Russia. The melting glaciers of the Alps feed the Rhine, which flows northward through West Germany to the North Sea. The Danube rises in West Germany and flows eastward past Vienna to the Black Sea. The Seine River winds northwesterly through eastern France and Paris into the English Channel. Other major rivers include the Don, Dnepr, Rhône, Vistula, Oder, Elbe, and Thames. Chief waterfalls include Gavarnie in France, Kile in Norway, Krimml in Austria, and Staubbach in Switzerland.

The salty Caspian Sea is really Europe's largest lake, because it is completely surrounded by land. The largest fresh-water lake is 7,100-square-mile Ladoga in Russia. Geneva, Constance, Como, and other clear blue Alpine lakes are famous for their beauty.

Natural Resources. The large-scale development of natural resources has helped make Europe one of the most productive regions on earth.

Minerals. The continent has 25 per cent of the world's coal reserve and 35 per cent of its iron and bauxite (aluminum ore), but these minerals are not evenly distributed. For example, the chief coal deposits lie in Great Britain, France, West Germany, Belgium, The Netherlands, Poland, and the Donetz River area of Russia. Spain, Italy, Norway, Sweden, and Greece have almost no coal. The richest iron-ore deposits lie in Great Britain, France, West Germany, Sweden, and Russia. Hungary, Yugoslavia, southern France, and Greece have the chief bauxite deposits.

The continent does not have enough petroleum to meet its needs. The only important petroleum deposits lie near the Caspian Sea in Russia, and in the Ploești region of Romania. Other minerals include copper, lead, zinc, and mercury.

Plant Life. Trees and flowering plants grow almost everywhere in Europe. However, the people have cleared most of the forests to make room for farms and cities. Almost nothing but mosses, lichens, and low shrubs grows on the *tundra*, or low, swampy plains that cover most of the Northwest Highlands and the areas near the Arctic Ocean. South of the tundra, a region of pine, fir, spruce, and other needle-leaf trees extends across northern Europe. Forests of oak and other hardwood trees once covered almost all the Central Lowlands. Most of these trees have been cut, but some thick forests of oak, beech, fir, and other trees still stand in such areas as the Black Forest of Germany and the Ardennes region of France, Belgium, and Luxembourg. Extensive areas have been replanted with quick-growing cone-bearing trees. Cork, evergreen, oak, olive, and other warm-climate trees grow along the Mediterranean Coast. *Steppes*, or grass-covered plains similar to the Great Plains of North America, cover much of the Ukraine region of southwestern Russia. A similar grassy area lies in central Spain. See the *Natural Vegetation Map* with this article.

Animal Life. Reindeer roam the tundra of Lapland and other regions of far northern Europe. Fur-bearing animals such as the lynx, marten, ermine, and badger also make their homes in the cold areas of Europe. Wisent, or European bison, live on game reserves in eastern Europe. The reddish-brown chamois makes its home in the Alps. Other wild animals include the bear, beaver, otter, elk, marmot, wolf, civet, fox, polecat, squirrel, hare, rabbit, mole, and hedgehog.

Birds native to Europe include the thrush, finch, snow bunting, house sparrow, wood pigeon, canary, eagle, falcon, owl, raven, and stork. Cod, hake, pollack, flounder, sardines, sturgeon, tuna, and other fishes swim in European waters.

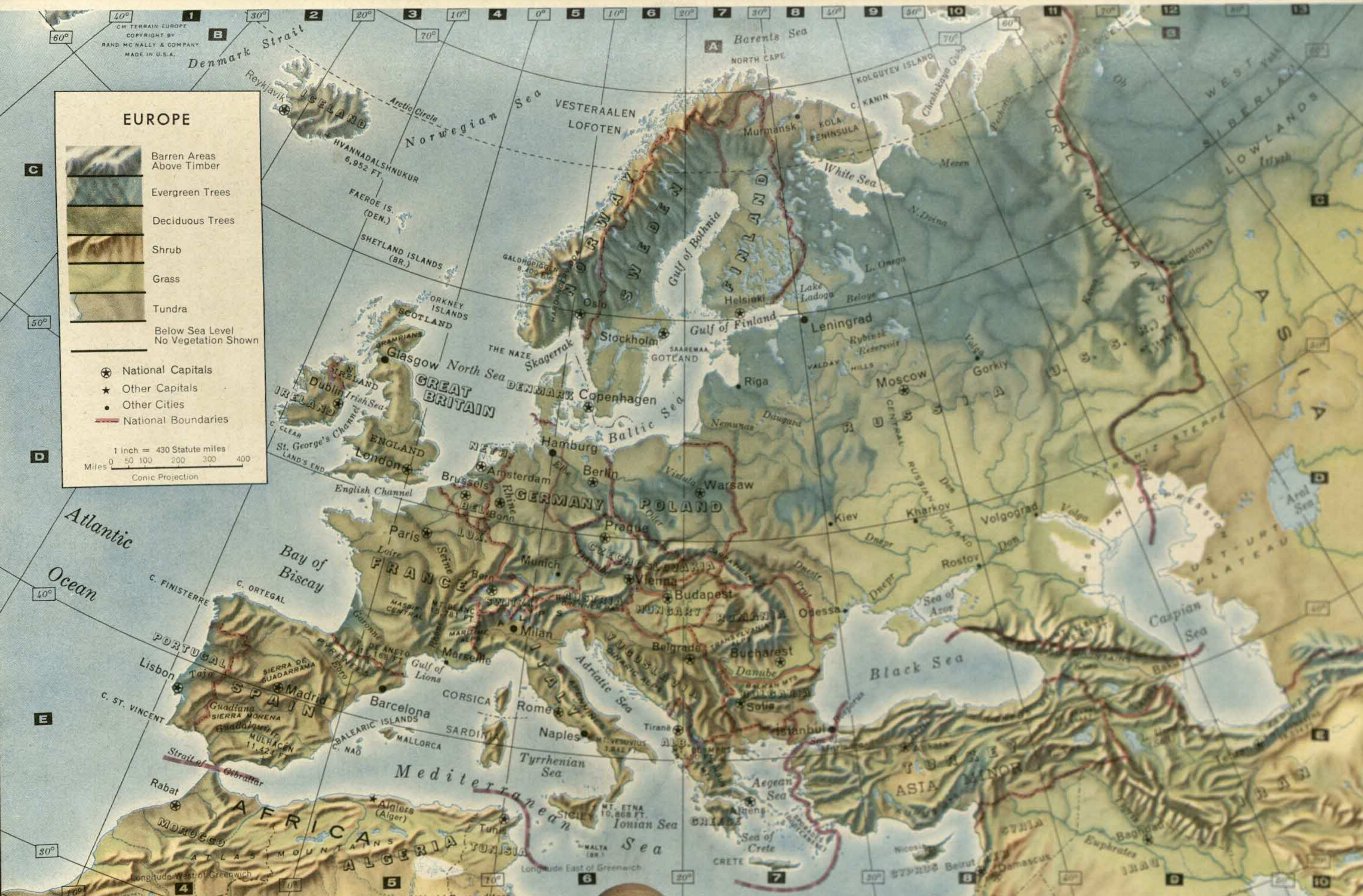
Climate. Europe lies as far north as Canada and the northern United States, but most of the continent has a milder climate than these areas. The North Atlantic Drift (a part of the Gulf Stream) warms the coastal waters of northwestern Europe and keeps them from freezing in winter. Westerly winds blowing across the coastal waters bring relatively warm air in winter to Iceland, the British Isles, western Norway, and western France. These areas have cool summers and mild winters. Average temperatures in London, which is farther north than Winnipeg, Canada, range from about 38°F. in January to 63°F. in July, compared with 3°F. and 67°F. in Winnipeg. Parts of Europe along the Mediterranean Sea have a warm, dry summer climate similar to that of Southern California.

From Central Europe eastward, the air from the oceans has less effect on the climate. In the interior, the winters become longer and colder, and the summers shorter and hotter. Average temperatures in Moscow range from 13°F. in January to 64°F. in July.

Most of Europe receives from 20 to 40 inches of rain a year. Winds carry rain-bearing clouds from the oceans to the coastal regions, and these areas generally receive more rain than the rest of Europe. Less than 10 inches of rain a year falls on the desertlike region near the Caspian Sea. See the *Rainfall* and *Temperature Maps*.

Regions of Europe

Europe is often divided into regions based on geography, history, culture, economics, or language. But scholars disagree on which countries make up each region, and the regions sometimes overlap.



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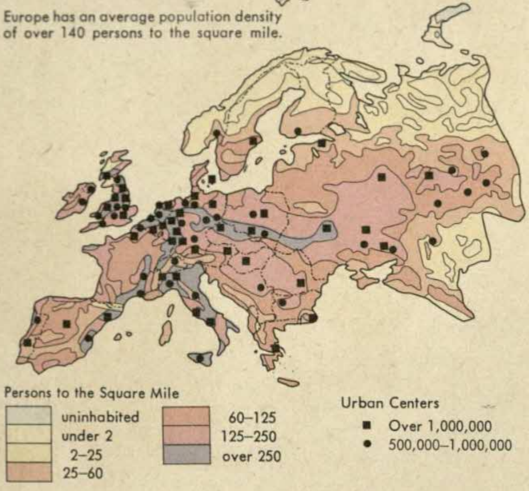
Barents Sea
RUSSIAN SOVIET FEDERATED
SOCIALIST REPUBLIC
RUSSIA
KAZAKSTAN
Sea of Azov
Black Sea
BULGARIA
GREECE
TURKEY
ASIA MINOR
SYRIA
IRAQ

EUROPE

The maps on this page show the variations in rainfall, population, and surface temperatures across the continent. They also indicate the principal ways the people earn their living.

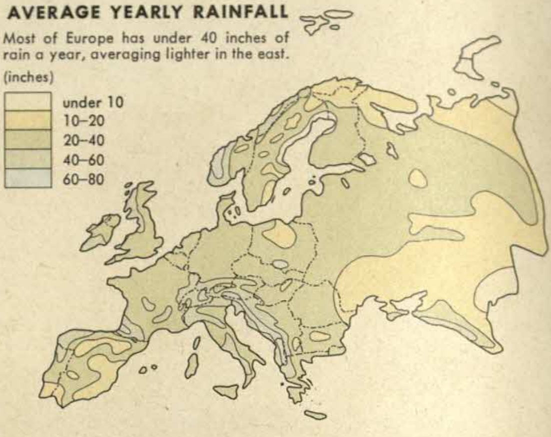
POPULATION

Europe has an average population density of over 140 persons to the square mile.



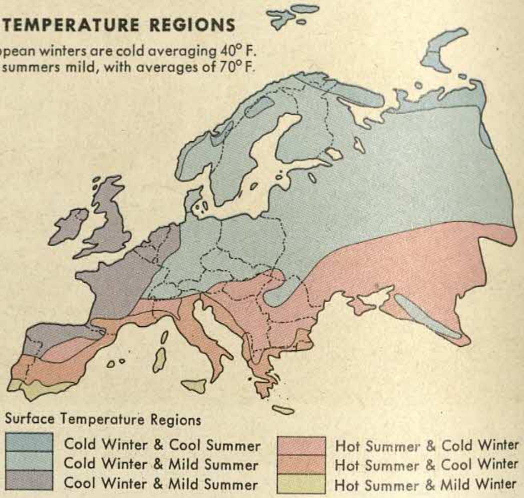
AVERAGE YEARLY RAINFALL

Most of Europe has under 40 inches of rain a year, averaging lighter in the east.



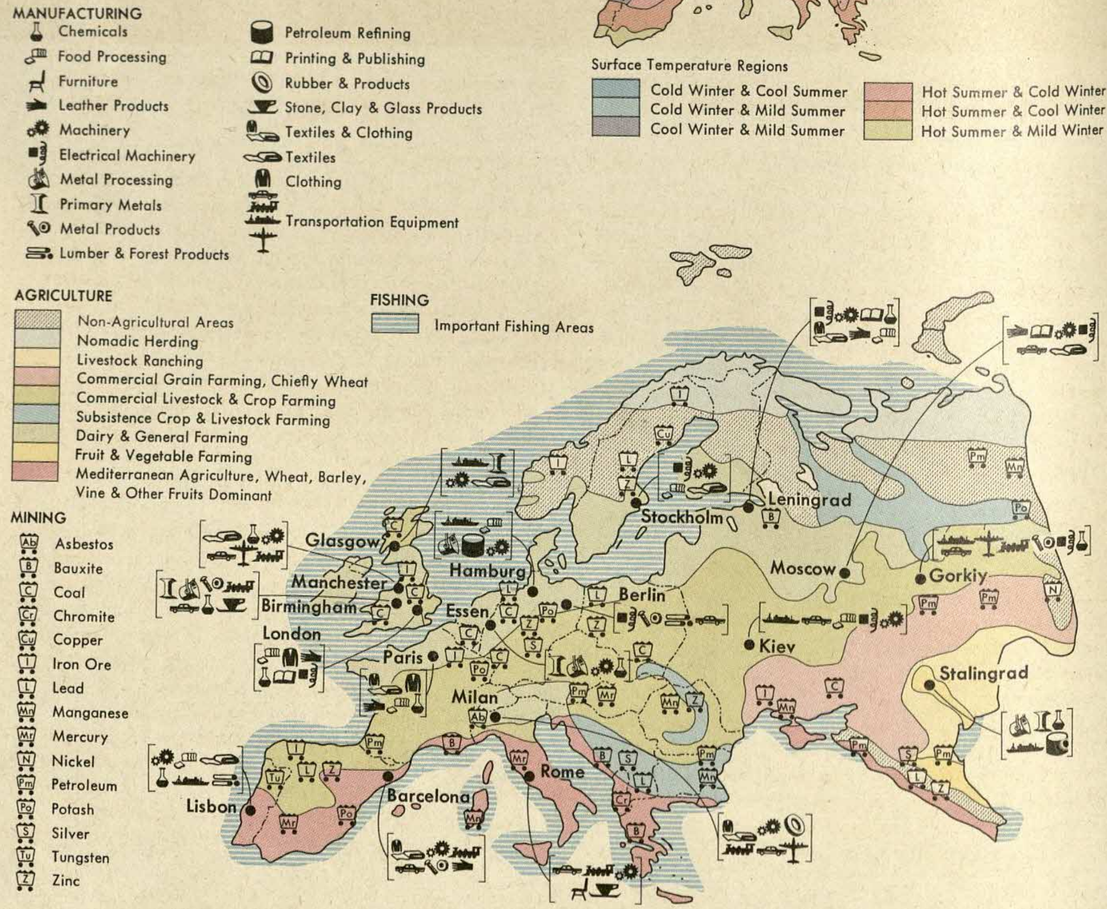
TEMPERATURE REGIONS

European winters are cold averaging 40° F. and summers mild, with averages of 70° F.


Surface Temperature Regions
Cold Winter & Cool Summer
Cold Winter & Mild Summer
Cool Winter & Mild Summer
Hot Summer & Cold Winter
Hot Summer & Cool Winter
Hot Summer & Mild Winter

ECONOMIC ACTIVITY

Europe leads all other continents in the production of coal.



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Pietzsch, Black Star

Lunch Time in Europe often brings the whole family together. Many European men, such as this gondolier in Venice, come home from work to eat their noonday meals. Several generations of the same family often live together.

Western Europe usually includes Great Britain, Ireland, France, Belgium, The Netherlands, Luxembourg, and Monaco. Except for Monaco and Luxembourg, all these countries face the Atlantic Ocean or its arm, the North Sea. The nations of Western Europe played a leading part in the development and spread of Western civilization. Western Europe is a world leader in commerce and industry. In 1948, Belgium, Luxembourg, and The Netherlands joined together in an economic union called *Benelux*. Since that time, they have been called the Benelux countries.

Denmark, Iceland, Norway, Sweden, and Finland are usually considered as *Northern Europe*, because of their geographic positions. This region is also called *Scandinavia*. The Scandinavians rank among the most prosperous and best-educated people in the world. The people of Sweden, Norway, Denmark, and Iceland speak similar Germanic languages.

Bulgaria, Romania, Hungary, Czechoslovakia, Poland, and part of Russia lie in *Eastern Europe*. Communist dictatorships rule all these nations. Most of the people speak Balto-Slavic languages such as Russian. Estonia, Latvia, and Lithuania are called the *Baltic States* because they face the Baltic Sea. Russia seized them in 1940 and brought them under communist rule.

Portugal, Spain, Andorra, Italy, Vatican City, San Marino, Greece, Albania, and Yugoslavia are usually considered *Southern European* nations. Most of these countries border the Mediterranean Sea. Yugoslavia, Albania, Greece, Bulgaria, and the European part of Turkey are called *The Balkans*, because they lie partly or entirely on the Balkan Peninsula. Romania, though not on the peninsula, is usually considered a Balkan country, because it has had close historical and political ties with other nations in the region. World War I and several other wars began in the Balkans, and this area is sometimes called "the powder keg of Europe."

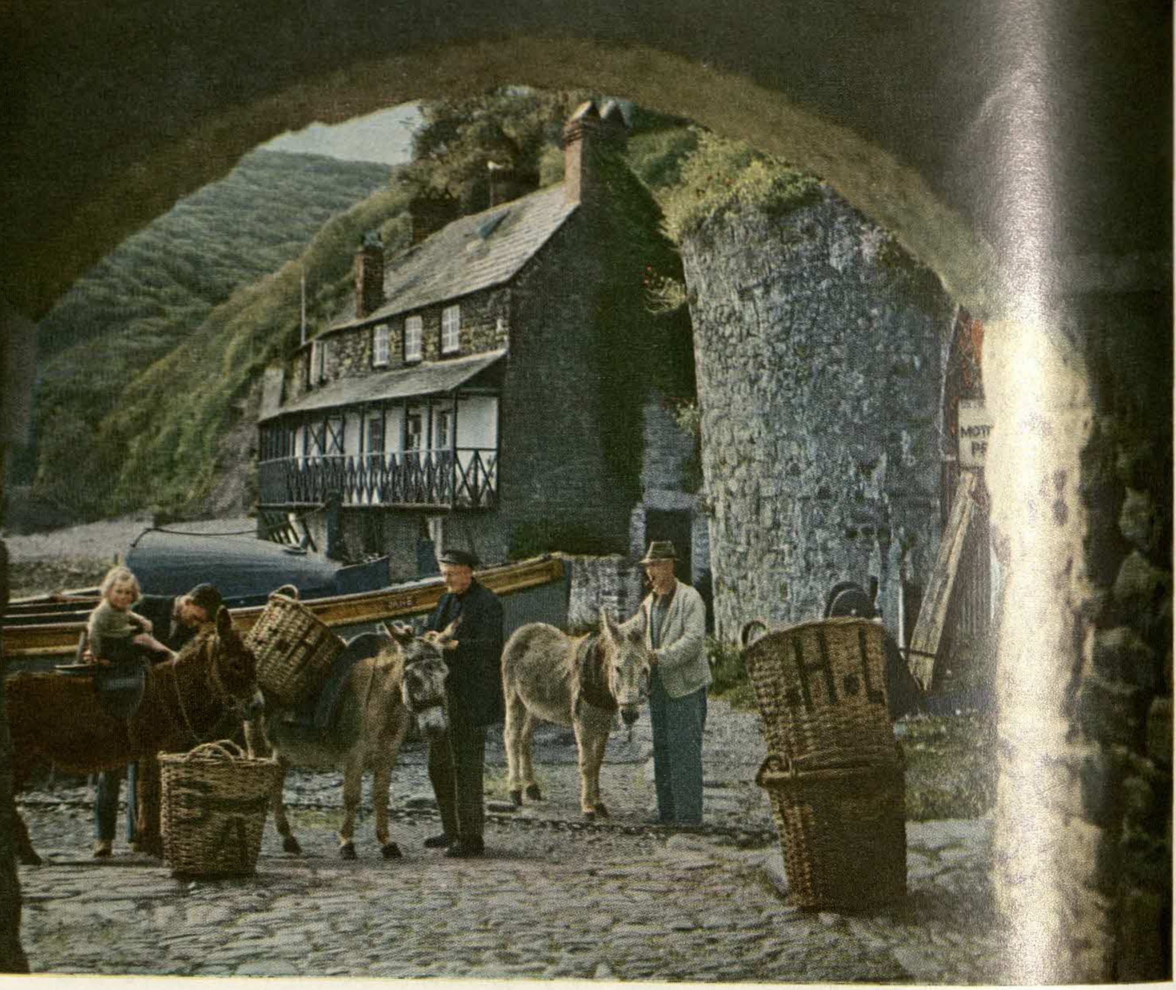
Germany, Switzerland, Liechtenstein, and Austria lie in *Central Europe*, and form a link with the other regions of the continent. Most of the people of these nations speak German.

Life of the People

The People. About 573,352,600 people live in Europe. An average of about 149 persons live on each square mile, making Europe the most densely populated continent. This population density is over three times that of the United States. An average of more than 500 persons live on every square mile in such countries as Great Britain, Belgium, West Germany, and The Netherlands. See the *Density of Population Map*.

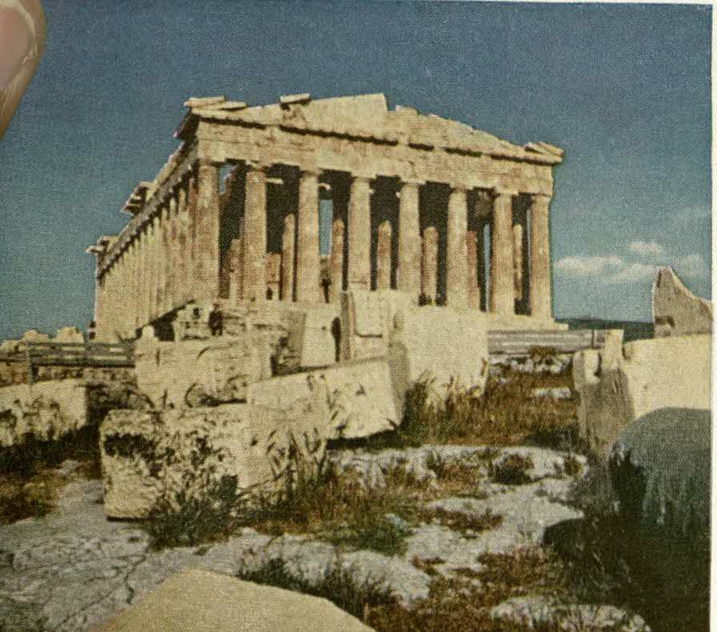
About 97 of every 100 Europeans are white. The largest of the many white groups of Europe include the Nordic, the East Baltic, the Alpine, the Dinaric, and the Mediterranean. See RACES OF MAN (Caucasoids).

Some European countries have more than one

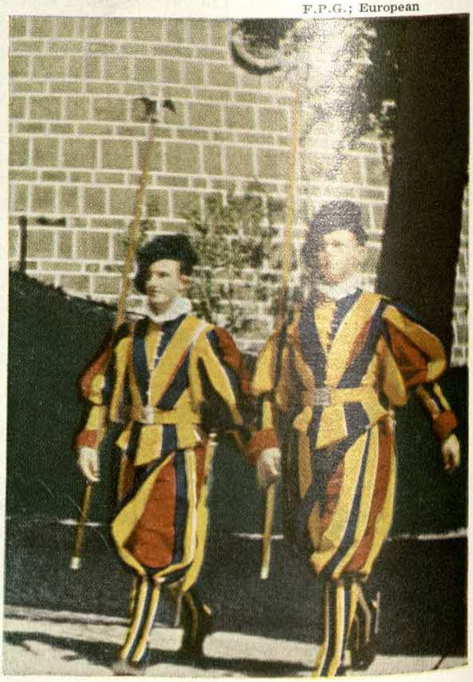


Clovelly, an English Fishing Village on the coast of Devonshire. It is built on a hillside, and its main street is so steep that donkeys are used as beasts of burden instead of horses. Automobiles and bicycles are not permitted. Clovelly is a favorite tourist resort. The village is one of the most picturesque in England.

F.P.G.; European



The Majestic Parthenon on the Acropolis of Athens is considered one of the world's most beautiful buildings. Built about 440 B.C., it has since served as Greek temple, Christian church, and Turkish mosque.



Swiss Guards Patrol Vatican City, in the city of Rome, Italy. Their colorful costume was designed by Michelangelo, in the 1500's.

A Bulgarian Farm Worker leads his team of oxen through the streets of a small country town. Bulgaria is a land of prosperous farms.

The Magnificent Swiss Alps, and the clear blue lakes at their feet, attract visitors from all parts of the world. This is the castle of Spiez on Thun Lake, in west-central Switzerland.

Pix; Three Lions; Braun, Shostal

A Flower Market In Brussels, Belgium. In this same square, merchants of the Middle Ages once gathered to talk and trade. Brussels is sometimes called "Little Paris" because of its beautiful buildings and wide streets.

nationality. For example, Yugoslavia has three national groups, the Serbs, Croats, and Slovenes. Each has its own language, customs, and traditions.

Language. About 60 different languages are spoken in Europe. They include three major language groups and several smaller ones. The people of Eastern Europe speak Balto-Slavic tongues such as Russian, Bulgarian, and Polish. The Teutonic languages of Northern Europe include Swedish, Danish, Norwegian, Dutch, Flemish, Icelandic, and German. Romanic, or Romance, languages spoken in Southern and Western Europe include French, Spanish, Portuguese, and Italian. Some scholars classify English as a purely Teutonic language, while others classify it as a combination of Teutonic and Romanic tongues.

Family Life in Europe generally resembles that in the United States. But families in most European countries are more closely knit than many American families. The home plays an important part in European family life. For example, European men often come home from work to eat lunch with their families. Men usually have more authority in family matters than women, and most parents raise their children strictly. In many parts of Europe, girls must ask their parents for permission to marry. In Russia and its satellites, the family has less importance than the state. As a result, family ties are not as close as those in other regions of Europe.

European homes include ancient castles, modern houses and apartment buildings, and small cottages made of wood, stone, or brick. Food ranges from simple meals of black bread, cheese, and potatoes to elaborate dinners prepared with great skill and care (see FOOD [Foods of Many Lands]). Most Europeans wear clothing similar to that worn in the United States and Canada. On special occasions, such as holidays and weddings, Europeans sometimes dress in their national costumes. See CLOTHING (color picture, Europe—National Costumes); SHELTER (In Europe).

City Life. The great age of most European cities makes them look much different from those in the United States and Canada. The ruins of buildings built before the time of Christ still stand in such cities as Athens and Rome. People in some cities worship in churches built before Christopher Columbus discovered America. London has won world fame for its historic buildings and royal pageantry. Beautiful Paris has long been a center of art and learning. Artists and writers from many countries go there to study and work. Vienna is famous for its gaiety and music.

Country Life in Europe varies from nation to nation, and from region to region within each nation. For example, farmers in Ireland, Scotland, Norway, and other areas live in houses in the midst of their fields. A nearby village or small town serves as a trading and recreational center. Farmers in Germany, southern France, and other regions live in villages surrounded by farm land. They often cultivate several small fields that are separated from each other by strips of land owned by other villagers. More than 99 per cent of the farmers in Russia, and many in its satellites, live and work on government-owned collective farms (see COLLECTIVE FARM). Privately owned European farms are much smaller than those in the United States. Most farms in Europe cover less than 25 acres, while the average farm in the United States occupies about 215 acres.

THE COUNTRIES OF EUROPE

Name	Area (sq. mi.)	Population	Capital
Albania	11,100	1,275,000	Tiranë
Andorra	175	5,664	Andorra
Austria	32,375	6,933,905	Vienna
Belgium	11,779	9,026,778	Brussels
Bulgaria	42,796	7,629,254	Sofia
Czechoslovakia	49,354	13,296,243	Prague
Denmark	16,576	4,387,967	Copenhagen
Finland	130,119	4,315,300	Helsinki
France	213,009	42,774,000	Paris
Germany (East)	41,537	17,832,200	Berlin (East)
Germany (West)	95,904	53,517,300	Bonn
Great Britain (includes England, Scotland, Wales, Northern Ireland)	94,212	50,784,600	London
Greece	51,182	7,631,124	Athens
Hungary	35,912	7,460,000	Budapest
Iceland	39,750	143,973	Reykjavík
Ireland	27,137	2,960,593	Dublin
Italy	116,311	48,560,000	Rome
Liechtenstein	61	13,571	Vaduz
Luxembourg	998	290,992	Luxembourg
Monaco	0.6	20,202	Monaco
Netherlands	15,765	10,550,737	Amsterdam
Norway	125,064	3,342,754	Oslo
Poland	120,359	27,423,000	Warsaw
Portugal	35,414	8,510,240	Lisbon
Romania	91,700	17,489,450	Bucharest
Russia (in Europe)*	1,914,939	155,296,000	Moscow
San Marino	23	12,950	San Marino
Spain	194,945	28,039,112	Madrid
Sweden	173,439	7,290,112	Stockholm
Switzerland	15,944	5,074,000	Bern
Turkey (in Europe)*	9,068	1,801,924	Ankara
Vatican City	0.2	890	Vatican City
Yugoslavia	99,181	16,936,573	Belgrade

Each country and capital has an article in WORLD BOOK

* Russia and Turkey lie in both Europe and Asia.

Farmers in Northern and Western Europe live much more comfortably than those in other parts of the continent. Farmers in this area have improved their living conditions by establishing cooperatives that resemble those in the United States and Canada (see COOPERATIVE). They use modern machinery to cultivate their fields, and most of the homes have electricity. Farmers in Spain, Greece, and most Eastern and Central European nations generally still use animals to cultivate their fields. They have few modern conveniences in their homes.

Work of the People

Agriculture. More Europeans work at crop farming and livestock raising than at any other occupations. Because their farms are so small, European farmers must cultivate their land more thoroughly than do farmers in North America. As a result, they usually produce more crops per acre than American farmers.

Before World War II, wealthy landowners controlled most of the farm land in the satellite countries. The communist governments took over most of this land for distribution to the farmers or for collective farms. Italy and France also carried out land reforms after 1945.

Europe produces more wheat, rye, potatoes, and sugar than any other continent. Farmers also raise oats, barley, and corn. Olives, grapes, and citrus fruits are important crops in Southern Europe. France also grows fine grapes. Most farmers in Northwestern Europe combine livestock raising with the production of grain, fruit, and vegetables. See AGRICULTURE (Europe).

Manufacturing and Processing. Europe is one of the world's great centers of manufacturing and processing. Great Britain ranks as a leader in the weaving of cotton and woolen textiles. People throughout the world drink the fine wines of France. The Ruhr Valley of West Germany is a leading iron and steel center. Swiss watchmakers make precise, delicate timepieces. Russia ranks among the leading producers of machinery. Other important industrial nations include Sweden, Belgium, The Netherlands, Italy, and Czechoslovakia.

Mining. Europe leads the world in coal mining. The leading coal-mining countries are Russia, Great Britain, West Germany, Poland, France, and Czechoslovakia. Six of the 10 leading iron-ore mining nations are in Europe: Russia, France, Sweden, Great Britain, West Germany, and Luxembourg. Large quantities of bauxite (aluminum ore) are mined in France, Hungary, Yugoslavia, and Greece. The only important petroleum production is in Romania and Russia. Other minerals found in Europe include copper, lead, zinc, mercury, gold, and silver.

Fisheries. Russia, Norway, Great Britain, Germany, Spain, France, and Iceland rank among the 10 leading fishery countries. The North Sea is one of the most heavily fished areas in the world, but fishing boats sail all the oceans and seas that border the continent. Whalers from Norway and other European countries sail as far south as the Antarctic Ocean. The chief fishery products include whale oil, caviar, cod, hake, pollack, flounder, sardines, and tuna.

The Tourist Industry ranks as an important source of income in many European countries. American tourists alone spend about $500,000,000 a year in Europe. More than 500,000 persons from the United States travel to the continent every year by airplane or ship. Many travel through the continent as individual tourists, others go as students, and some join tours conducted by various travel companies. Motoring is a popular way of seeing Europe, and tourists often buy or rent automobiles on the continent. Other tourists enjoy hiking or cycling. Accommodations range from luxurious hotels to inexpensive youth hostels (see YOUTH HOSTEL). Travel restrictions imposed by the communist nations of Eastern Europe limit the number of tourists that visit these countries.

Power. Most European countries have well-balanced sources of power. For example, most nations that lack abundant coal deposits have large hydroelectric resources. Europe uses water power more extensively than any other continent. Italy, Russia, Sweden, France, and Norway rank among the leading water-power nations of the world. In proportion to their populations, Switzerland, Norway, and Sweden outrank all other countries in the use of water power.

The first large-scale electric plant powered by atomic energy began operating in 1956 in Great Britain. In 1957, West Germany, Italy, France, The Netherlands, Belgium, and Luxembourg signed a treaty to establish a European atomic-energy authority called *Euratom.* The six nations planned to pool their atomic resources for peaceful uses.

Transportation. Mountains in many areas have made the construction of roads and railroads difficult and expensive. Despite this handicap, most European nations have excellent transportation systems.

Aviation. European airlines fly routes throughout the continent and to other parts of the world. The governments of the various countries own many of the airlines. For a description of several European airlines, see AIRLINE (Major Airlines).

Railroads in almost every European country are government-owned. Crack trains link all parts of the continent. Trains traveling in the Alps speed through the longest railroad tunnels in the world (see TUNNEL [Railroad Tunnels]).

Roads and Highways range from the *autobahn,* the German system of freeways and expressways, to unpaved country lanes. In addition to trucks, buses, and automobiles, thousands of Europeans use bicycles, motor scooters, and motorcycles.

Shipping has long been one of the chief European industries. Only the United States has a larger merchant fleet than Great Britain. Other important shipping countries include Denmark, France, West Germany, Italy, The Netherlands, Norway, Sweden, Greece, and Russia. Europe has 6 of the 10 leading ports in the world: London; Lisbon, Portugal; Rotterdam, The Netherlands; Istanbul, Turkey; Antwerp, Belgium; and Hamburg, West Germany.

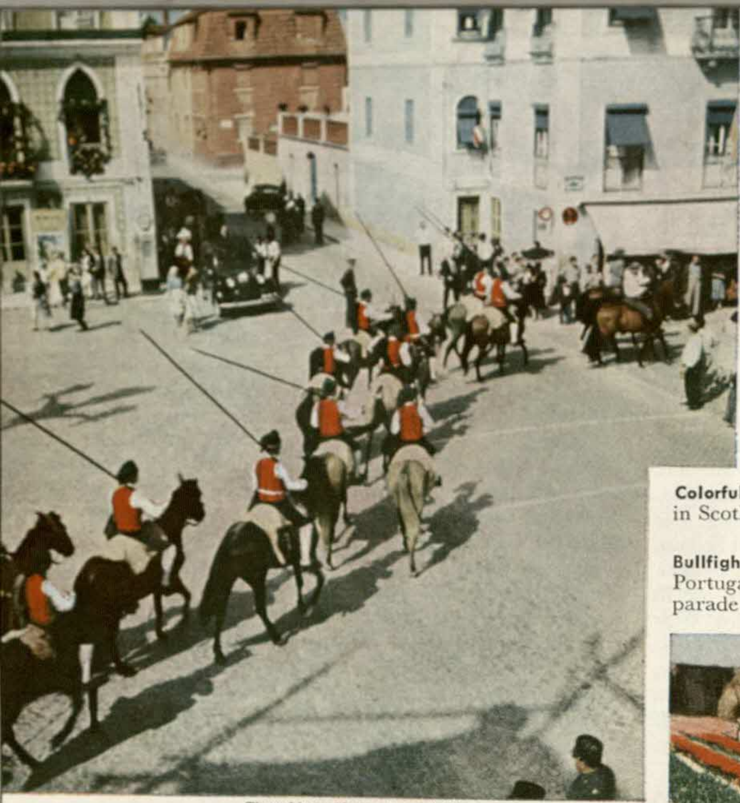
Waterways. Barges and other vessels travel on the rivers and canals that crisscross the continent. The Rhine and Danube are the chief navigable rivers. See CANAL (Canals of Europe; British Canals).

Communication. Europe has the two largest daily newspapers in the world. The London *Daily Mirror* and the London *Daily Express* each publish more than 4,000,000 copies a day. Great Britain leads the world in daily newspaper circulation, and also ranks as the leading book-publishing nation. Radio stations broadcast in every European country, and most of the nations have television stations. A privately-owned television network called *Eurovision* serves Western Europe. Programs are broadcast in the language of the country in which they originate. Telephone and telegraph lines connect all parts of the continent. In almost every European country, the government owns the telephone and telegraph system. Many television and radio stations are also government-owned.

Activities of the People

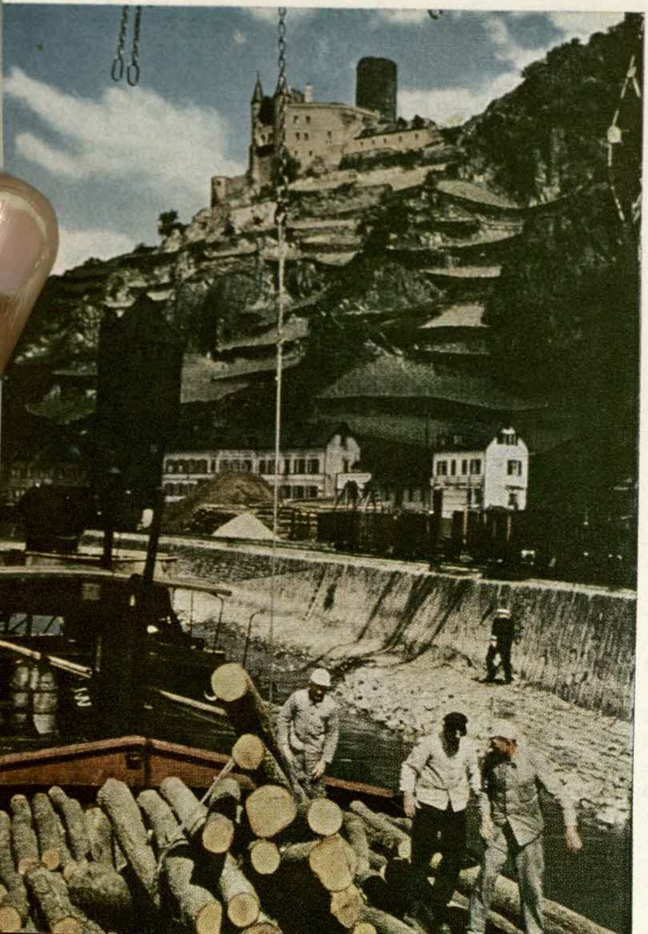
Education. The nations of Northern, Western, and Central Europe have less illiteracy than almost any other countries in the world. For example, more than 99 per cent of the people of Sweden can read and write. Austria, Belgium, Denmark, France, Germany, Great Britain, Iceland, The Netherlands, Norway, and Switzerland also have extremely high literacy rates.

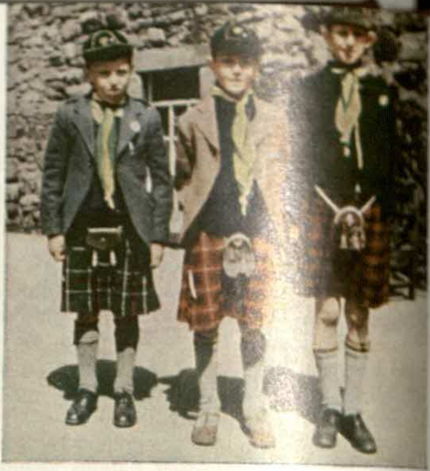
Other European countries are poorer and have had less opportunity to develop good school systems. As a result, most of the nations of Eastern and Southern Europe have a higher percentage of people who cannot read or write. However, these nations have made



Three Lions; Moore, Shostal; Shostal; Kammerman; F.P.G.

Lumber from a German Forest is being loaded on a barge at St. Goarshausen. The castle on the terraced hill overlooks the Rhine River, famous in German history and legend.



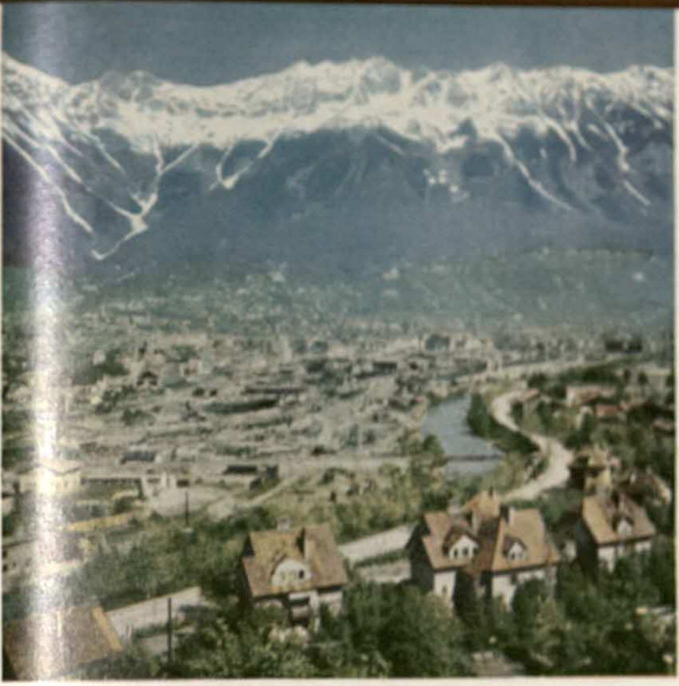


Colorful Scottish Tartans and Sporrans are worn in Scotland, even by Cubs and Boy Scouts.

Bullfighting Is the Popular Sport in Spain and Portugal. *Picadores* or *campinos* carry lances and parade the streets before a fight.

Tulip Time in The Netherlands. A holiday is declared when the blooms are at their peak.

Blarney Castle, near Cork, Ireland. Here may be seen the Blarney Stone of song and legend.

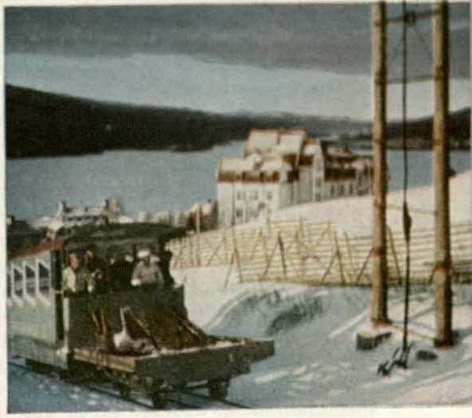


Innsbruck, Capital of the Austrian Province of Tyrol. It is beautifully situated among the Tyrolese Alps on the banks of the Inn River. Its colorful past helps to make it a popular tourist center.

The Cathedral of Reims, France, is one of the greatest pieces of Gothic architecture, despite being damaged in two world wars.

Street in the French City of Cherbourg, on the English Channel. The city is an important seaport for transatlantic commerce, and was a landing place for Allied military supplies in World War II.

An Exposition Building at a Moscow Agricultural Fair. Visitors to the fair came from many parts of the widespread Soviet Union.



A Swedish Winter Resort near Are, Sweden, has many facilities for winter sports, such as this inclined railway to take skiers uphill.

U. S. Army; Harrison Forman; Swedish Travel Inf. Bur.

notable gains in education during the 1900's. For example, two thirds of the Spanish people could not read or write in 1900. Today, less than one fourth are illiterate.

Until the 1940's, few European countries had a system of universal education similar to that of the United States. Most children attended elementary school, but few went on to high school or college. Higher education was reserved largely for children of wealthy or upper-class families who studied to become political and business leaders. Since the 1940's, several countries have worked toward systems of universal education, but in most countries higher education is still limited to only a small percentage of the people.

Most European students, especially those in high schools and colleges, study more traditional academic subjects, such as literature, history, and philosophy, than do students in the United States. Schools in Russia and its satellites emphasize communist doctrine as well as scientific and technical training. World-famous European universities include Oxford, Cambridge, London, and Glasgow in Great Britain; the University of Dublin in Ireland; Heidelberg University in West Germany; and the universities of Paris, Rome, and Moscow. For a history of European education, see EDUCATION, HISTORY OF.

Libraries, Museums, and Art Galleries in Europe rank among the finest in the world. Leading European libraries include the Bibliothèque Nationale in Paris, the Bodleian Library at Oxford, the Vatican Library in Vatican City, and the Lenin Library in Moscow. The British Museum in London is probably the most famous European museum. Distinguished art galleries include the Louvre in Paris, the National Gallery in London, the Uffizi and Pitti palaces in Florence, the Rijks Museum in Amsterdam, the Kaiser Friedrich Museum in Berlin, and the Museo del Prado in Madrid.

Religion. Europe is one of the great centers of Christianity. Vatican City is the home of the Roman Catholic Church, and Germany was the birthplace of Protestantism. The continent has produced great religious leaders such as Saint Thomas Aquinas, John Calvin, John Duns Scotus, John Knox, Martin Luther, and John and Charles Wesley. Famous churches and cathedrals include those at Florence, Italy; Cologne, West Germany; Reims, Paris, and Chartres, France; Saint Peter's Church, Vatican City; the Cathedral of Saint Mark, Venice; and Lincoln Cathedral in Lincoln, England.

The great majority of Europeans are Christians. More than half the Christians are Roman Catholics, most of whom live in Southern and Western Europe and in Ireland. The rest of the Christians are about evenly divided between the Eastern Orthodox churches and various Protestant groups. Eastern Orthodox people live chiefly in Southeastern and Eastern Europe. Most of the Protestants in Europe live in the northern part of the continent. Europe also has about 12,000,000 Moslems and 3,000,000 Jews.

The communist governments of Europe try to substitute communism for religion. They persecute religious groups and try to discourage religious worship. Despite this oppression, millions of persons in communist countries continue to practice their religions.

The Arts. The classic temples and public buildings of ancient Greece and Rome, the stately Gothic cathedrals of the Middle Ages, and the magnificent palaces of the Renaissance stand as monuments to the genius of European architects. Painters such as El Greco, Da Vinci, Michelangelo, Rembrandt, Cézanne, Renoir, Van Gogh, and Picasso have produced many of the world's finest paintings.

Plays by ancient Greek dramatists such as Aeschylus, Aristophanes, Sophocles, and Euripides remain popular today. The Renaissance and the years following it produced Shakespeare, Petrarch, Dante, and other world-famous writers. People in every country read the works of more recent European literary figures such as Tolstoy, Goethe, Molière, Wordsworth, and Shaw.

Europe was the birthplace of the symphony, the ballet, and the opera. It has produced such musical giants as Bach, Beethoven, Brahms, and Mozart.

For a history and description of the arts in Europe, see ARCHITECTURE; BALLET; DANCING; DRAMA; LITERATURE; MUSIC; OPERA; PAINTING; SCULPTURE.

Philosophy. The writings of Aristotle, Desiderius Erasmus, Plato, Karl Marx, John Locke, and other European philosophers have influenced social and political thought throughout the world. The leaders of the American Revolution based much of their thinking on the works of Locke. Marx developed the theory of communism, and inspired communist movements in Russia and other countries.

Science. Europeans have contributed such outstanding scientific discoveries as vaccination, X rays, radium, bacteria, how the blood circulates, and the structure of the solar system. Europeans invented the automobile, microscope, steam engine, spinning wheel, spinning jenny, locomotive, gasoline engine, and wireless telegraph. They also played a leading part in the development of radar and jet propulsion. Enrico Fermi and other European scientists working in the United States perfected the process of splitting the atom.

History

Early Days. Scientists disagree on how long men have lived in Europe and where they first came from. Many believe the earliest ancestors of Europeans may have lived 1,000,000 years ago. Scientists have found fossils that indicate Neanderthal man probably lived in Europe between 100,000 and 50,000 B.C. Cro-Magnon man, the first physical type of modern man, was the first known artist. Pictures of animals painted by these early Stone Age people have been found in caves throughout Europe. Scientists believe the paintings are from 10,000 to 50,000 years old. See PREHISTORIC MAN.

The Greeks. The first important European civilization developed on Crete and other islands in the Aegean Sea. Aegean civilization on Crete flourished from about 3000 to 1400 B.C. See AEGEAN CIVILIZATION.

The first advanced civilization on the European mainland developed in Greece. This civilization reached its greatest heights between 500 and 300 B.C. Athens and other Greek city-states developed the idea of self-government. See GREECE, ANCIENT.

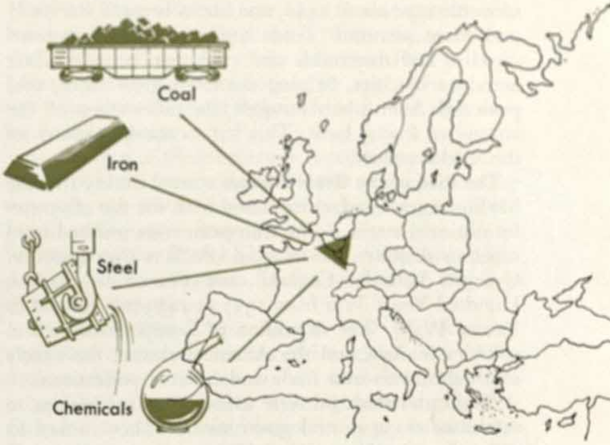
The Romans developed the next important European civilization. They borrowed so many ideas from the Greeks that scholars sometimes speak of the Greek and

Koenig, Black Star

INDUSTRIAL EUROPE

Assembly Lines of Europe make products for the world. The Volkswagen plant at Wolfsburg, West Germany, is one of several European automobile factories that sell cars to the United States and Canada.

Europe's Industrial Triangle, one of the world's most productive regions, centers where the countries of France, West Germany, Belgium, and Luxembourg meet.



Roman civilizations together as the *Greco-Roman* civilization.

Tradition says that Rome was founded in 753 B.C. It became a republic in 509 B.C., but did not reach its greatest power until 500 years later. Julius Caesar conquered all of what is now France and neighboring areas to the east between 58 and 49 B.C., when he became dictator of Rome. By the A.D. 100's, the Roman Empire extended from one end of the Mediterranean Sea to the other, and as far north as the British Isles.

Christianity became the official religion of the Roman Empire during the late A.D. 300's. During this same period, the Roman Empire split into two parts, the West Roman Empire and the East Roman, or Byzantine, Empire. Constantinople (now Istanbul, Turkey) became the capital of the Byzantine Empire, and Rome was the capital of the West Roman Empire. See BYZANTINE EMPIRE; ROMAN EMPIRE.

The Germanic Invasions. Several Germanic tribes lived along the borders of the Roman Empire. These included the Angles, Saxons, Jutes, Franks, Burgundians, Vandals, Visigoths, and Ostrogoths. During the late 300's, fierce Mongolian tribesmen called Huns swept into Europe from Asia and forced the tribes to flee to the Roman Empire. The Visigoths invaded Italy in the 400's, and attacked and pillaged Rome in 410. They then marched into Spain and began a successful struggle with the Vandals for control of the area. During the 400's, the Angles, Saxons, and Jutes invaded present-day England, and the Franks occupied what is now northeastern France and Belgium. The Burgundians took southeastern France.

Odoacer, a German leader, overthrew the last West Roman Emperor, Romulus Augustulus, in 476. This ended the West Roman Empire. The Byzantine Empire lasted another 1,000 years.

The Middle Ages covered the 1,000-year period from the fall of the West Roman Empire to the late 1400's. Clovis, the first great Frankish king, conquered present-day France, Belgium, and The Netherlands, and much of western Germany in the late 400's and early 500's. The Frankish kingdom achieved its greatest power under Charlemagne, who ruled from 768 to 814. His kingdom extended from the Pyrenees Mountains to what is now Denmark, and as far south as central Italy. Charlemagne tried to revive the West Roman Empire, and in 800 Pope Leo III crowned him Emperor of the Romans. After Charlemagne died in 814, his empire broke up into smaller kingdoms. The Holy Roman Empire, founded by Otto I of Germany in 962, was a partial revival of Charlemagne's empire, but it was not as large. See CHARLEMAGNE; HOLY ROMAN EMPIRE.

Feudalism became the dominant way of life on the continent during the Middle Ages. Great lords owned most of the land and controlled the lives of the people. The Roman Catholic Church also owned much land, and its religious influence played a major part in European life. See FEUDALISM; MIDDLE AGES.

The Moslem Influence. During the early 600's, Mohammed founded the Islamic religion in Arabia (see ISLAM). By the 700's, the new religion had spread throughout the Middle East, across North Africa, and into Spain. This great Moslem empire included more land than the Roman Empire.

The Moslems contributed much to the culture of Christian Europe. For example, they had preserved many writings of the ancient Greeks, and European scholars were able to study them. The Moslems founded great universities in Spain, and made important contributions in medicine and mathematics. They introduced into Europe the system of Arabic numerals that we use today. Moslems remained powerful in Spain until the 1200's, when the Christians began driving them out. The last Moslems left Spain by 1492. See ISLAMIC ART; SPAIN (History).

The Crusades also brought Europeans into contact with Moslem civilization. The Crusades began as military expeditions designed to free Palestine from the

Moslem Turks. But the Europeans profited from trading with the Moslems, and the later Crusades largely became trading ventures. See CRUSADES.

The Renaissance. During the 1100's, European scholars, especially in Paris, began to turn from church-dominated education to Greek and Roman philosophy and literature. This movement reached its peak during the Renaissance, which began in the 1300's (see RENAISSANCE).

Portuguese sailors explored the west coast of Africa in the 1300's. Christopher Columbus sailed to the West Indies in 1492, and six years later Vasco da Gama became the first European to reach India by sea.

Johannes Gutenberg, a German printer, developed movable type about 1440, and books became less costly and more plentiful. Trade and commerce expanded rapidly, and merchants and craftsmen centered their activities in cities, helping the cities grow strong and powerful. After a hard struggle, the cities threw off the control of feudal lords. This led to the breakdown of the feudal system.

The Rise of the Great Powers started during the late Middle Ages. Warfare increased with the rise of powerful national states. Some European wars resulted from religious disputes, others from conflicts over territory. Quarrels between England and France led to the Hundred Years' War from 1337 to 1453 (see HUNDRED YEARS' WAR). The expansion of European trade and colonies in Asia and the Americas during the 1500's resulted in wars over trade and colonial possessions.

Spain and Portugal were among the first nations to establish strong central governments. They ranked as the most powerful nations in Europe during the 1400's and 1500's. England, France, and The Netherlands grew powerful after the decline of Spain and Portugal. England defeated The Netherlands after several wars in the 1600's, and the contest for power then lay between the British and the French. At the same time, Prussia and Russia also became great powers in the world.

The Reformation began in 1517 and led to the foundation of the Protestant religion. The new faith spread to many parts of Europe, and the Roman Catholic Church no longer stood as the only Christian church on the continent (see REFORMATION). Conflicts between Roman Catholics and Protestants resulted in a long series of great religious wars that ended with the Thirty Years' War. Most of Europe was involved in this war which stretched between 1618 and 1648. See THIRTY YEARS' WAR.

Civil Wars and Revolutions broke out throughout Europe after the disappearance of feudalism. Merchants, farmers, and lesser nobles began demanding equality under the law, freedom from taxation without representation, liberty of trade and travel, and freedom of speech and religion.

The "Glorious Revolution" in England in 1688 established the principles of parliamentary government and gave the English people their Bill of Rights (see BILL OF RIGHTS; ENGLAND [The Restoration]). The kings of France ruled as absolute monarchs until the French Revolution began in 1789. This 10-year uprising gave the French people the Declaration of the Rights of Man (see FRENCH REVOLUTION; RIGHTS OF MAN, DECLARATION OF THE).

RED LETTER DATES

c. 3000 to 1400 B.C. Aegean civilization flourished on Crete.
c. 500 to 300 B.C. Greek civilization reached its greatest heights.
49-44 B.C. Julius Caesar ruled as dictator of Rome.
A.D. 476 The German leader Odoacer overthrew the last West Roman emperor, Romulus Augustulus.
800 Pope Leo III crowned Charlemagne Emperor of the Romans.
1096-1291 Europeans waged the Crusades to free Palestine from the Moslems.
1300's The Renaissance began in Europe.
1337-1453 France won the Hundred Years' War against England.
1517 The Reformation brought Protestantism to Germany.
1618-1648 The Thirty Years' War engulfed most of Europe.
1688 The "Glorious Revolution" established parliamentary government in England and gave the English people the Bill of Rights.
1789-1799 The French Revolution ended absolute monarchy in France.
1815 Great Britain, Prussia, Belgium, and The Netherlands crushed Napoleon in the Battle of Waterloo.
1870-71 France lost the Franco-German War.
1914-1918 The Allies defeated Germany in World War I.
1917 The Bolshevik Revolution established a communist dictatorship in Russia.
1939-1945 World War II devastated Europe and resulted in the downfall of Hitler and Mussolini.
1946 The "cold war" began, dividing Eastern and Western Europe with an "iron curtain."
1948-1951 The United States helped Western Europe with the European Recovery Program (Marshall Plan).
1949 The nations of Western Europe joined the United States and Canada in a defense pact, the North Atlantic Treaty Organization (NATO).
1952 Western Europe took a step toward unity with the formation of the European Coal and Steel Community.
1957 West Germany, Italy, France, The Netherlands, Belgium, and Luxembourg agreed to form a European Economic Community designed to end trade barriers.
1958 European Economic Community and European Atomic Energy Community became effective.

In 1799, Napoleon I made himself dictator of France. By 1812, he controlled the mainland of Europe from Spain to the border of Russia. In that year, Napoleon launched the disastrous march on Moscow that resulted in the ruin of his mighty army. British, Russian, Prussian, Swedish, and other allied armies defeated Napoleon after a series of battles, and he was exiled to the island of Elba in April, 1814. The French conqueror regained control of France briefly in 1815, but the combined might of Great Britain, Prussia, Belgium, and The Netherlands crushed him at the bloody Battle of Waterloo.

The Franco-Prussian War (1870-71), which resulted in a French defeat, was the only major conflict on the continent between 1815 and the beginning of World War I in 1914 (see FRANCO-PRUSSIAN WAR). However, revolutions broke out in many areas. Uprisings against absolute monarchy began in Naples and Spain in 1820, and in Greece in 1821. Democratic revolts also developed in France, Belgium, Germany, and Poland in the early 1830's. In 1848, the king of Sardinia gave his people their first written constitution (see SARDINIA, KINGDOM OF). The king of Prussia granted his people a constitution in 1850. Italy was founded as a national state in 1861, followed by Austria-Hungary in 1867 and Germany in 1871. By 1900, nearly every European nation except Russia had a constitution and at least some democratic institutions. In Russia, the revolution of 1905 forced Czar Nicholas II to grant the first Russian constitution. Several of the constitutions granted during this period were not liberal, especially those of Austria, Hungary, and Prussia. Poverty, political persecution, and other factors caused millions of Europeans to migrate to the United States.

World War I resulted from struggles for power between various European nations. The great conflict began in 1914 with Russia, France, and Great Britain opposing Germany and Austria-Hungary. The fighting spread quickly and soon involved most of the nations of Europe, and several in other areas of the world. The United States joined the Allies in 1917, after German submarines had sunk several American ships. In November, the Bolshevik revolution in Russia led to the establishment of a communist dictatorship, and Russia withdrew from the war. In 1918, the Allies beat back the last great German offensive in France, and on November 11 Germany signed an armistice. The Treaty of Versailles officially ended the war in 1920. See VERSAILLES, TREATY OF; WORLD WAR I.

World War I and the Treaty of Versailles changed the map of Europe. Poland, Czechoslovakia, Yugoslavia, Latvia, Estonia, and Lithuania all won independence as a result of the war. Austria and Hungary became separate states.

Between World Wars. World War I left many problems unsettled. Many of the victorious nations kept their military forces strong, while the defeated countries began rebuilding their armed strength. The world-wide economic depression that began in 1929 hit Europe hard. An atmosphere of gloom aided the growth of communism and fascism in several countries. The leaders of these movements found millions of people ready to accept their promises of better living and working conditions. In the 1920's, Joseph Stalin began his career as dictator of communist Russia. Benito Mussolini made himself absolute ruler of Italy in 1922. Adolph Hitler rose to power in Germany in the early 1930's.

World War II. The Spanish Civil War (1936-1939) served as a testing ground for the military might of Hitler, Mussolini, and Stalin. The Russians supported the Spanish Loyalists, and Germany and Italy sent military aid to the victorious rebel forces of General Francisco Franco. Hitler seized Austria in 1938 and Czechoslovakia in 1939. On September 1, 1939, Germany invaded Poland and touched off World War II.

Great Britain, France, and their allies bravely tried to stem the German advance through Europe. But by 1941 Hitler and Mussolini occupied or controlled a large part of the European mainland. Hitler's forces invaded Russia in June of that year, and swept nearly as far as Moscow. Japan attacked the United States on December 7, 1941, at Pearl Harbor in Honolulu, and World War II spread to the Pacific Ocean. In 1943, the Russians broke the German siege of Stalingrad and drove out the invaders. The Allies invaded Italy and forced the surrender of that country in September, 1943. Allied forces landed in northern France on June 6, 1944, and liberated Western Europe. The surrender of Germany on May 8, 1945, ended the European phase of World War II. See WORLD WAR II.

Postwar Economic Problems. Chaos and confusion followed the end of World War II. Thousands of homeless refugees wandered through the devastated battle areas, and famine and disease spread rapidly. The United States helped the nations of Western Europe with the European Recovery Program (Marshall Plan), which began in 1948. Aid to Europe under the Marshall Plan totaled more than $11,000,000,000 in loans and credits. Other United States assistance programs followed the end of the Marshall Plan in 1951. Most Western European nations by 1951 were producing more than they did before the war. Yet they were far from prosperous.

In the face of these economic troubles, several European countries adopted some form of socialism. For example, the British Labour party won control of the House of Commons in 1945. The Labour government nationalized the Bank of England and the coal, transport, and other industries. It also established a system of socialized medicine.

The Cold War. After World War II, Russian-controlled communist dictatorships seized most of the nations of Eastern Europe and all the Balkan Peninsula except Greece and Turkey. Poland, Albania, and Bulgaria fell to communist control in 1946, followed by Romania in 1947 and Hungary and Czechoslovakia in 1948. Yugoslavia established its own brand of communism and managed to remain free from Russian control.

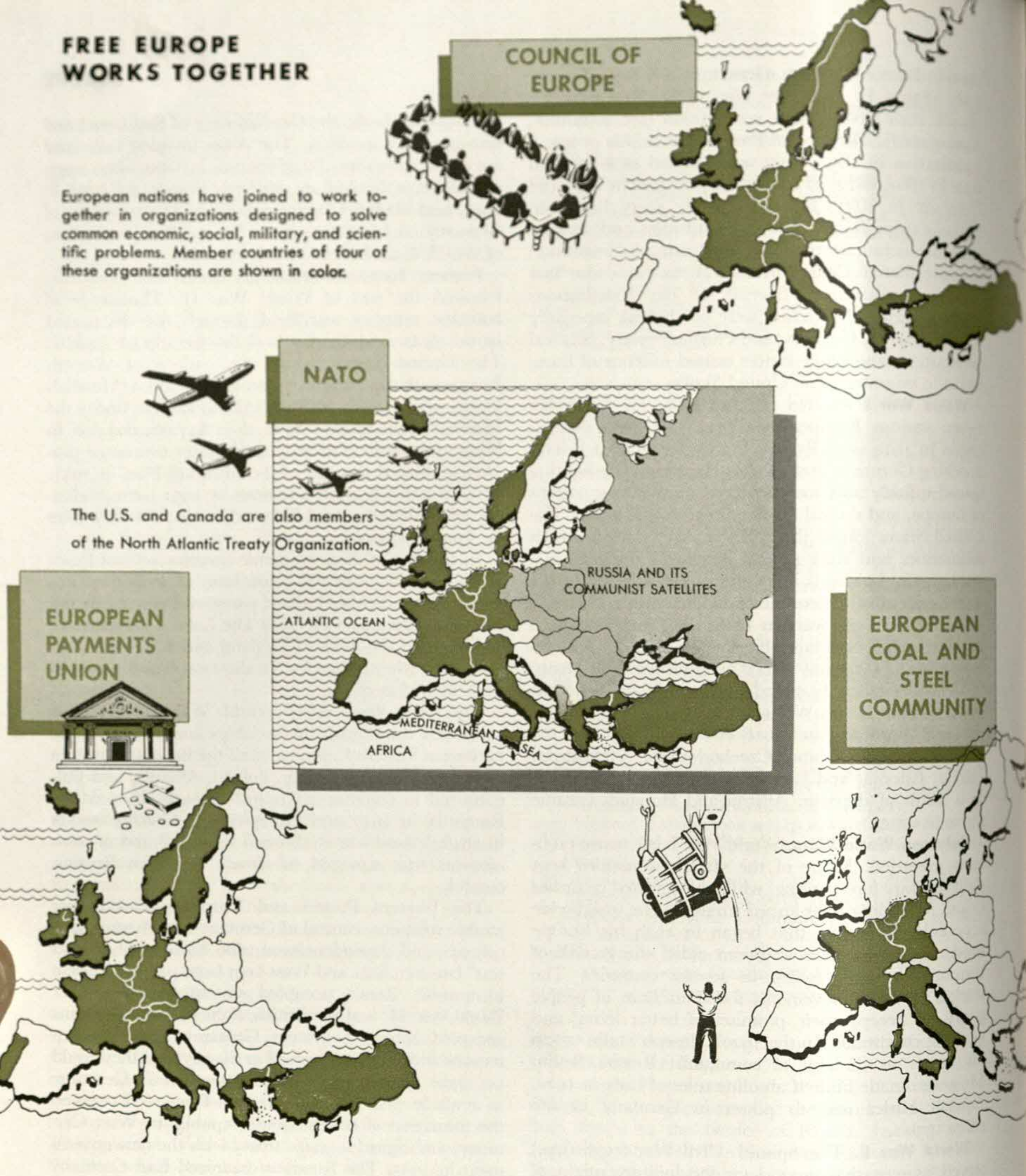
The Western Powers and Russia quarreled over atomic weapons, control of Germany and Austria, and colonies and dependencies outside Europe. The "cold war" between East and West kept large parts of Europe in turmoil. Russia occupied eastern Germany after World War II, and the British, French, and Americans occupied zones in western Germany. The Western nations and Russia disagreed so sharply that they could not come to terms on a peace settlement for Germany as a whole. In 1949, the Western Powers encouraged the formation of a democratic republic in West Germany, and signed a peace treaty with the new government in 1955. The Russians organized East Germany as a communist state in 1954. The peace settlement with Austria also caused problems (see AUSTRIA [After World War II]).

As Soviet fear and suspicion of the West deepened, Russia cut itself and its satellites off from the rest of the world. Winston Churchill called this division between East and West the "iron curtain." In 1949, the United States and Canada joined with most of the nations of Western Europe to form the North Atlantic Treaty Organization (NATO) as a defense against communist aggression (see NORTH ATLANTIC TREATY ORGANIZATION).

Toward European Unity. The nations of Western Europe banded together into several organizations dur-

FREE EUROPE WORKS TOGETHER

European nations have joined to work together in organizations designed to solve common economic, social, military, and scientific problems. Member countries of four of these organizations are shown in color.



The U.S. and Canada are also members of the North Atlantic Treaty Organization.

ing the late 1940's and the 1950's. They hoped that by dropping trade barriers and working together they could solve many of their economic problems. See EUROPE, COUNCIL OF; EUROPEAN COAL AND STEEL COMMUNITY; EUROPEAN PAYMENTS UNION.

In May, 1955, Great Britain, France, Italy, Belgium, The Netherlands, Luxembourg, and West Germany organized a defense alliance called the Western European Union (see WESTERN EUROPEAN UNION). Also in 1955, Russia and its satellites signed a mutual defense agreement known as the Warsaw Pact. The communist nations agreed to place their armed forces under a single command. However, Russia had controlled these military forces since the late 1940's.

Western Europe took another step toward unification in 1957. West Germany, Italy, France, The Netherlands, Belgium, and Luxembourg signed an agreement to establish a European Economic Community. Under this pact, the nations agreed to abolish gradually all tariffs on goods passing between them. At the same time, the nations signed a pact for a European Atomic Energy Authority (Euratom). In 1958, the two organizations became effective. That same year the people of the six nations elected members of the European Economic Assembly. Robert Schuman of France was elected president by the Assembly.

EDWARD MCNALL BURNS

Related Articles. See the separate articles on the countries and capitals listed in the table with this article. See also the following articles in World Book:

History

See the History section of the Reading and Study Guide for detailed study outlines listing the articles in World Book that refer to the history of Europe. See also:

Balkans
Baltic States
Benelux
Byzantine Empire
Charlemagne
Crusades
Euratom
Europe, Council of
European Coal and Steel Community
European Monetary Agreement
European Recovery Program
Franco-Prussian War
Greece, Ancient
Middle Ages
Napoleon I
North Atlantic Treaty Organization
Reformation
Renaissance
Revolution of 1848
Roman Empire
Western European Union
World War I
World War II

Peoples

Basque
Cossack
Czech
Gypsy
Lett
Magyar
Ruthenian
Slav
Slovak
Walloon

Physical Features

See Island; Lake; Mountain; River, with their lists of Related Articles. See also:

Adriatic Sea
Aegean Sea
Arctic Ocean
Atlantic Ocean
Azov, Sea of
Baltic Sea
Bay of Biscay
Black Sea
Bosporus
Caspian Sea
Dardanelles
English Channel
Gulf of Bothnia
Marmara, Sea of
Mediterranean Sea
North Sea
Scandinavia

Products

Barley
Coal
Iron and Steel
Oats
Rye
Sheep
Wheat

Outline

- **I. The Land and Its Resources**
  - A. Location and Size
  - B. Land Regions
  - C. Coast Line
  - D. Rivers, Waterfalls, and Lakes
  - E. Natural Resources
  - F. Climate
- **II. Regions of Europe**
- **III. Life of the People**
  - A. The People
  - B. Language
  - C. Family Life
  - D. City Life
  - E. Country Life
- **IV. Work of the People**
  - A. Agriculture
  - B. Manufacturing and Processing
  - C. Mining
  - D. Fisheries
  - E. The Tourist Industry
  - F. Power
  - G. Transportation
  - H. Communication
- **V. Activities of the People**
  - A. Education
  - B. Libraries, Museums, and Art Galleries
  - C. Religion
  - D. The Arts
  - E. Philosophy
  - F. Science
- **VI. History**

Questions

Where did the first important European civilization develop?

Where is the world's first large-scale, atomic-powered generating plant?

What effect does the North Atlantic Drift have on the climate of Europe?

What is Euratom? Eurovision?

What part did the United States play in the economic recovery of Europe after World War II?

Who coined the phrase *iron curtain?*

Where are the longest railroad tunnels in the world?

What part did the Moslems play in the history of Europe?

What important resource do most European countries lack?

What is the smallest nation in the world?

What is the only active volcano on the European mainland?

What important inventions have come from Europe?

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EUROPE, COUNCIL OF, is an international organization of 15 European countries. The council seeks to promote closer unity among its members in order to achieve economic and social progress. The organization has no real power, and can only advise on economic, social, legal, cultural, scientific, and other matters. It concentrates mainly on European policy toward the rest of the world, and on the internal political organization of Europe.

The council consists of a joint committee, a secretariat-general, a committee of ministers with one member from each nation, and a consultative assembly made up of 138 delegates. The size of each country determines the number of its delegates.

Member nations are Austria, Belgium, Denmark, France, Great Britain, Greece, Iceland, Ireland, Italy, Luxembourg, The Netherlands, Norway, Sweden, Turkey, and West Germany. The Saar was an associate member until 1957. Established in 1949, the council has headquarters at Strasbourg, France. EDWARD McNALL BURNS

EUROPEAN ATOMIC ENERGY COMMUNITY. See EURATOM.

EUROPEAN COAL AND STEEL COMMUNITY is an international organization that controls the coal, iron, and steel industries of Belgium, France, Italy, Luxembourg, The Netherlands, and West Germany. The community creates a common market for these products by forbidding import restrictions among the members. It regulates prices, production, markets, and wages, and imposes fines for violations of its decisions.

A nine-member High Authority does the actual work of the Coal and Steel Community. But it is responsible to a 78-member Common Assembly. The community also includes a court of justice and a council of ministers. It has headquarters in the city of Luxembourg. Robert Schuman of France proposed the European Coal and Steel Community in his *Schuman Plan* of 1950, and it began work in 1952. EDWARD McNALL BURNS

EUROPEAN COMMON MARKET. See EUROMARKET.

EUROPEAN ECONOMIC COMMUNITY. See EUROMARKET.

EUROPEAN INVESTMENT BANK. See EUROMARKET.

EUROPEAN MONETARY AGREEMENT is a system under which 18 European countries jointly settle their trade accounts with each other. The agreement established a European Fund of about $600,000,000. The fund is maintained by periodic payments from the participating nations. A member can borrow from the fund to cover trade deficits with other members. This enables a member country to keep trading with other members even if it is temporarily importing more than it is exporting.

The European Monetary Agreement was established in 1958, with headquarters in Paris. It replaced the European Payments Union. Nations taking part in the agreement are Austria, Belgium, Denmark, France, West Germany, Great Britain, Greece, Iceland, Ireland, Italy, Luxembourg, The Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, and Turkey. EDWARD McNALL BURNS

EUROPEAN PLAN, in hotels. See HOTEL.

EUROPEAN RECOVERY PROGRAM encouraged the cooperation of European nations for economic recovery after World War II. The United States agreed to send aid to Europe if the countries would meet to decide what they needed. The program was often called the *Marshall Plan* because Secretary of State George C. Marshall first suggested it. The Marshall Plan began in April, 1948, when Congress established the Economic Cooperation Administration (ECA) to administer foreign aid. Seventeen nations formed the Organization for European Economic Cooperation (OEEC) to assist the ECA and develop cooperation among its members. The United States sent more than $11,185,000,000 in food, machinery, and other products to Europe. About $1,-200,000,000 went for direct military assistance. Marshall Plan aid ended in 1951. In 1961, the Organization for Economic Cooperation and Development (OECD) succeeded the OEEC. Twenty nations, including the United States and Canada, formed the OECD to promote the economic growth of member nations and to aid underdeveloped areas. EDWARD McNALL BURNS

See also MARSHALL, GEORGE C.; MARSHALL PLAN; TRUMAN, HARRY S. (The Marshall Plan).

EUROPIUM, *yoo ROH pih um* (chemical symbol, Eu), is one of the rare-earth metals. Its atomic number is 63, and its atomic weight is 152.0. The French scientist Eugène Demarçay first discovered the element in 1901. He named it *europium* in honor of Europe. Europium occurs in cerium minerals. The soft, silver metal is prepared by vacuum distillation of a mixture of europium oxide and lanthanum metal or mischmetal. It corrodes easily. It melts at about 1,520° F., and boils at about 2,640° F. Scientists hope to use europium in control rods for nuclear reactors. See also ELEMENT, CHEMICAL; RARE EARTH. FRANK H. SPEDDING

EURYDICE, *yoo RID ih see*, was the beloved wife of the musician Orpheus in Greek mythology. Aristaeus, the beekeeper, saw her one day and fell in love with her. She ran from him when he tried to make love to her. As she ran, a snake bit her foot, and she died. She had not been dead long when Orpheus came to bring her back to earth. Hades, king of the dead, was so charmed by his music that he let her go back. Orpheus was told not to look back at her on the way. But he did, and Eurydice vanished from his sight. JOSEPH FONTENROSE

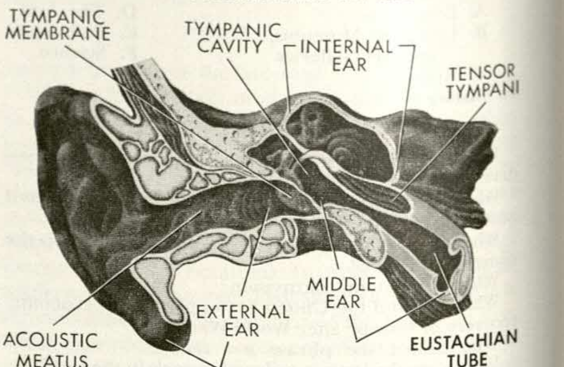
See also ORPHEUS.

EURYSTHEUS. See HERCULES.

EUSDEN, LAURENCE. See POET LAUREATE.

EUSTACHIAN TUBE, *yoo STAY kih un*, is a *canal*, or passage, about 1½ inches long, composed of bone and cartilage, and lined with mucous membrane. The tube

The Eustachian Tube Connects the Ear with the Throat.



passes forward, in, and down from the middle-ear cavity to the throat. The Eustachian tube allows the air to pass from the throat to the middle ear. Swallowing helps open the tube. Therefore, when descending in an elevator or airplane, swallowing helps adjust the air pressure on the inner side of the eardrum to the air pressure on the outside. Severe pain and poor hearing result from a marked difference in air pressure between the middle ear and the outside air. The tube also allows mucus formed in the middle-ear cavity to escape into the throat. Infections often pass through the Eustachian tube from the throat to the middle ear.

Bartolommeo Eustachio (1520-1574), an Italian physician who helped found the study of anatomy, discovered the Eustachian tube. Carl C. Francis

See also Ear.

EUTERPE. See Muse.

EUTHANASIA, *you thuh NAY zhih uh,* is the practice of painlessly putting to death persons who have incurable, painful, or distressing diseases or handicaps. It comes from the German words for *well,* or *good,* and *death,* and is commonly called "mercy killing." Voluntary euthanasia occurs when the person asks his physician to put him to death. Euthanasia is illegal in the United States, Canada, and every other civilized country. The Nazis under Adolf Hitler carried on a form of euthanasia in an attempt to "purify" the German population (see Genocide).

Euthanasia is opposed by most religious groups, which consider it suicide or murder and, therefore, immoral. Supporters of euthanasia claim that it rids society of unfit persons and those who are burdens on society, such as the aged, habitual criminals, and persons with incurable illnesses. They also claim that it would purify the race and eliminate human waste. C. S. Mihanovich

EUXINE, *YOOK sin,* **SEA** is the ancient name of the Black Sea. See Black Sea.

EVANGELICAL ALLIANCE is an international Protestant association formed in London in 1846. Its purpose was to unify the Protestant churches and extend the Christian faith. Members of churches from England, France, Germany, Ireland, Scotland, Switzerland, and the United States founded the organization. It has branches throughout the world. The alliance was one of the earliest expressions of a trend toward church unity, called the *ecumenical movement.* Howard R. Burkle

EVANGELICAL AND REFORMED CHURCH was a Protestant denomination that merged in 1957 with the Congregational Christian Churches to form the United Church of Christ (see United Church of Christ). For membership of each of these two churches, see Religion (table).

The Evangelical and Reformed Church was originally formed in 1934. It united the Reformed Church of the United States, founded in 1725, and the Evangelical Synod of North America, organized in 1840. The church based its standards of doctrine on the Heidelberg Catechism, Luther's Catechism, and the Augsburg Confession. Wherever these standards differed from each other, the ministers and members of their churches could decide which one they would follow. The church allowed freedom of worship, but recommended forms of worship and hymns for common use.

A general synod governed the Evangelical and Reformed Church. It met every three years. The church established three theological seminaries, eight colleges, and three academies. It was active in home mission work, and also maintained missions in Central America, Asia, and Africa.

EVANGELICAL UNION. See Thirty Years' War.

EVANGELICAL UNITED BRETHREN is the name of a church formed in 1946 by a union of the Evangelical Church and the United Brethren in Christ. Both groups had organized in 1800, and both followed the doctrines and methods of Methodism (see Methodists). A preacher named Jacob Albright founded the Evangelical group among the German settlers in Pennsylvania. Until 1922, it was called the Evangelical Association. The United Brethren in Christ originated near Frederick, Md. Leaders of this group were a German Reformed pastor, Philip William Otterbein, and a Mennonite preacher, Martin Boehm. The Evangelical United Brethren carry on missionary work in various parts of the world. For the church membership, see Religion (table). G. E. Epp

EVANGELINE, *ee VAN juh leen* or *ee VAN juh line,* is the name of the first long narrative poem by Henry Wadsworth Longfellow. The poem tells the tragic history of two lovers, Evangeline and Gabriel. They lived in the French colony of Acadia, in what is now Nova Scotia. The two families celebrated the official engagement of Evangeline and Gabriel. But, on the very next day, the entire colony was ordered into exile. The two sweethearts were accidentally separated, and Evangeline began her long search for Gabriel.

She floated down the Mississippi River with a band of the exiles. Gabriel passed her raft while it was anchored at the shore, but Evangeline did not know this, and continued her search. In Louisiana, she found his father, but Gabriel had just left. In Michigan, she again arrived too late.

Evangeline came to feel that she was chasing a phantom. She became a Sister of Mercy in Philadelphia, and found Gabriel at last when he was an old man dying of the plague in an almshouse. Evangeline was buried beside him.

Evangeline on Her Way to the Catholic Church in the village of Grand Pré, Nova Scotia. The heroine of Longfellow's poem is walking alone, carrying a prayer book and rosary.

Visual Education Service

Visual Education Service

A Scene from the Story of Evangeline shows the Acadians protesting in anger as the British general reads a royal order demanding that the Acadians swear allegiance to Great Britain.

Nathaniel Hawthorne may have considered making this tale into a novel because Longfellow asked his permission to develop the story in a poem. Hawthorne agreed to this. *Evangeline* was published in 1849, and became one of the most popular poems written by an American. It is written in hexameter verse, the same form that Homer used in writing his Greek epics (see METER [in poetry]).

The note of gentleness with which the poem begins never falters. Longfellow's use of poetic imagery and quiet drama have contributed to the poem's popularity. A statue of Evangeline by Henri Hébèrt stands at Grand Pré, Nova Scotia, the village where the lovers first met. GEORGE ROBERT CARLSEN

See also ACADIA; LONGFELLOW, HENRY WADSWORTH; LOUISIANA (Interesting Places to Visit); NOVA SCOTIA (color picture, Evangeline Memorial Park).

EVANGELINE OAK is an oak tree on the banks of the Teche River in St. Martinville, La. It was named for the heroine of Henry W. Longfellow's poem *Evangeline* (see EVANGELINE). In the poem, Evangeline and Gabriel were separated when they had to leave Acadia (Nova Scotia). Evangeline reached the home of Gabriel's father in Louisiana, but Gabriel had left. In her grief, she wandered off to the oak tree and wept. Tradition says the real lovers met beneath the tree. KNOX WILSON

See also LOUISIANA (Interesting Places to Visit).

Evangeline Oak, according to tradition, was the meeting place of the real lovers portrayed in Longfellow's poem, *Evangeline.*

Marius Barbeau, National Museum of Canada

EVANS, SIR ARTHUR JOHN (1851-1941), a British archaeologist, became known for the excavations he began on the island of Crete in 1893. He discovered an unknown or unsuspected form of writing in Crete. It preceded the writing of the Phoenicians. He also uncovered the Palace of Minos at Knossos, on which most of our knowledge of the pre-Greek Minoan civilization is based (see KNOSSOS).

Evans was born in Hertfordshire, England, and was graduated from Oxford and Göttingen (Germany) universities. He was curator of the Ashmolean Museum at Oxford. He wrote the four-volume *Palace of Minos* (1922-1935). Evans was knighted in 1911. DAVID B. STOUT

EVANS, JOHN. See COLORADO (Famous Coloradans).

EVANS, MARY ANN, or **MARIAN.** See ELIOT, GEORGE.

EVANS, MAURICE (1901-   ), an actor and theatrical manager, became noted for such Shakespearean roles as Richard II, Falstaff in *Henry IV (Part I)*, and Macbeth. His full-length production of *Hamlet* was particularly famous. During World War II, he gave *Hamlet* for troops in the Pacific area.

Evans was born in Dorset, England. He became popular in London for his acting in *Journey's End*, and with the Old Vic company. After 1935, he won great success in the United States in such plays as *Romeo and Juliet*, *St. Helena*, *Man and Superman*, and *Dial M for Murder*. He appeared on television in *Hamlet*, *Richard II*, *Macbeth*, and *Man and Superman*. Maurice Evans became an American citizen in 1941, and performed for Allied soldiers in World War II. MARY VIRGINIA HEINLEIN

Friedman-Abeles

Maurice Evans

EVANS, MOUNT. See MOUNT EVANS.

EVANS, OLIVER (1755-1819), an American inventor, millwright, and steam-engine designer, built what is considered America's first automobile (see AUTOMOBILE [The Steam Car]). In 1805, he completed building a steam-operated dredge that was to be used in the Philadelphia harbor. Axles and wheels carried the huge craft, and an engine propelled it to the water, thus earning the claim of the first automobile. Evans also built many steam engines, and machinery for flour mills. He designed a steam-propelled

Brown Bros.

Oliver Evans

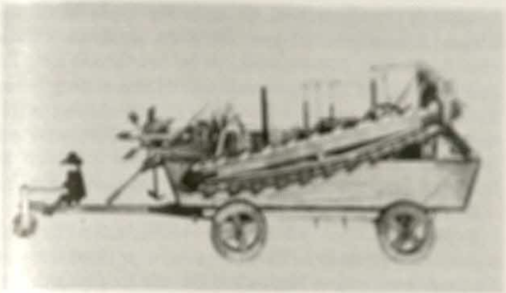


Photo of model by Greville Bathe

The First Self-Propelled Vehicle in the United States was Oliver Evans' "Orukter Amphibolos," or "Amphibious Digger."

carriage, but it was never built. He is known to have said, "The time will come when people will travel in stages moved by steam engines from one city to another almost as fast as birds fly—15 to 20 miles an hour." Evans was born in Newport, Del. He became a wagon-maker's apprentice at 14. SMITH HEMPSTONE OLIVER

EVANS, ROBLEY DUNGLISON (1846-1912), was an American naval officer known as "Fighting Bob." He first won recognition in 1891 as commander of the gunboat *Yorktown* in the harbor of Valparaiso, Chile. While there, he peaceably settled a crisis after a mob killed two American sailors.

Evans was born in Floyd County, Virginia, and was graduated from the United States Naval Academy. During the Spanish-American War, he commanded the battleship *Iowa*, and helped destroy the Spanish fleet at Santiago de Cuba. In 1902, Evans, now a rear admiral, took command of the Asiatic Fleet. President Theodore Roosevelt chose him to take the Atlantic Fleet around the world in 1907. DONALD W. MITCHELL

EVANSTON, Ill. (pop. 79,283; alt. 600 ft.), a residential suburb of Chicago, lies north of the city on Lake Michigan (see ILLINOIS [color map]). Northwestern University was chartered there in 1851. Evanston is the home of the Garrett Biblical Institute (Methodist), Seabury Western Theological Seminary (Episcopal), National College of Education, and the Cradle Society, an agency for finding homes for needy children. Rotary International and the Woman's Christian Temperance Union have headquarters in Evanston. The city was founded in 1854 and incorporated in 1863. It has a council-manager government. PAUL M. ANGLE

EVANSVILLE, Ind. (pop. 141,543; alt. 385 ft.), is an industrial and trade center on the Ohio River, about 165 miles southwest of Indianapolis (see INDIANA [color map]). Five large railroad systems and several branch railways serve the city. Factories in Evansville make automobiles, refrigerators, air-conditioning equipment, steam shovels, furniture, building materials, tile, pottery, breakfast foods, and tools.

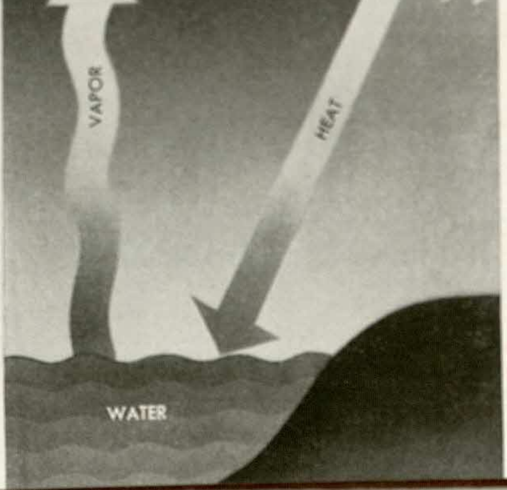
Founded in 1816, Evansville soon became an important trade center because many steamboats traveled the Ohio River after 1817. It received its city charter in 1847. Evansville has a mayor-council form of government. It is the home of Evansville College and the county seat of Vanderburgh County. PAUL E. MILLION, JR.

EVANSVILLE COLLEGE is a privately endowed coeducational liberal arts school at Evansville, Ind. It offers nursing, medical technology, education, music, business administration, journalism, engineering, premedicine, prelaw, and pretheology courses. Courses in engineering are taught on a cooperative plan. Students alternate work in industry and study in college. The college was founded in 1854. For enrollment, see UNIVERSITIES AND COLLEGES (table). MELVIN W. HYDE

EVAPORATED MILK is whole sweet milk from which about 60 per cent of the water has been removed. Evaporated milk is prepared by heating pasteurized homogenized whole milk in vacuum tanks to evaporate the water. The concentrated milk is canned, sealed, and immediately sterilized by heat. Evaporated milk, unlike condensed milk, has no sugar added to preserve it, but vitamin D is often added for nutrition. John Meyenberg, a Swiss inventor, received patents in 1884 for the first successful means of concentrating milk without adding sugar. See also MILK; CONDENSED MILK.

EVAPORATION, *ee vap oh RAY shun,* is the process which changes a substance from the liquid or solid state into a vapor or gas. Many substances can be a solid, a liquid, or a vapor, depending on the temperature or the amount of pressure to which they are subjected. Water left standing in an open dish in a warm room soon "dries up." Damp clothes hung on a line in the sunshine lose all their moisture in a short time. Heat in the air changes the *water* in them to *water vapor*. The warmer and drier the air, the more rapidly this process of evaporation goes on. We generally use the word evaporation when the process occurs at everyday temperatures, and use other words, such as *boiling* or *vaporization*, for higher temperatures.

Vapor in Air. In warm weather, the air may contain a great deal of vapor. At 90°F., there may be almost twice as much as at 70°F. Air contains little vapor at the freezing point. But some moisture always remains in the air. Nothing can live in moisture-free air. When air has all the vapor it can hold at a given tem-



Evaporation of Water by the sun's heat causes vapor to rise and form clouds and fog.

perature, it is *saturated*, or at *dew point*. This seldom happens, except when it rains. Air that contains much moisture is said to be *humid*. But humid air usually has much less moisture than the amount needed to saturate it. The humidity is extremely high in tropical regions, especially near the sea, while in cooler climates it decreases greatly. A person can stand much more cold when the air contains only a little vapor. This explains why cold winds that blow over water seem more biting than winds farther inland, even though the temperature is the same.

In some large areas, plants and animals could not live except for evaporation. Water evaporates from oceans, lakes, rivers, ponds, and the moist earth, and later falls as rain on these areas. Living things would die there without the precious rain water. Clouds often show the humidity in air. If the clouds form rapidly, or if small cloud patches grow rapidly, the humidity is increasing. If the cloud area becomes smaller, the air probably is becoming drier.

Evaporation in Plants is called *transpiration*. Plants absorb moisture through their roots and lose it by evaporation through their leaves, or transpiration. The more leaf surface exposed, the more rapid is the transpiration. The structure of such leaves as pine needles prevents rapid transpiration.

Evaporation takes place from the surface of a liquid at any temperature. It also takes place from solids, for even ice and snow send off vapor. This can often be noticed a day or two after a snowstorm. The snow disappears from the ground, even though the temperature has never gone above freezing. The water evaporates directly from the solid without first becoming a liquid. Formation of vapor in this way is called *sublimation*. Some substances, like solid iodine, do this more easily than others. Moth balls contain a chemical that possesses this property.

Uses of Evaporation. When a liquid evaporates from the surface of something, that surface becomes much cooler because it requires heat to change a liquid into a vapor or gas. An electric fan cools us off because its current of air makes perspiration evaporate quickly. The heat needed for this evaporation is taken from our own bodies. The same rule works when we sprinkle the sidewalk on a hot day. As the water evaporates, it uses up heat and cools the air above the walk. Ether, ammonia, alcohol, and some other liquids evaporate much more rapidly than water. In operations under ether, doctors must take special precautions so that the patient will not get pneumonia. The rapid evaporation of ammonia requires much heat and is important in refrigerators and cold-storage plants.

RALPH G. OWENS

Related Articles in WORLD BOOK include:

Cloud
Dew
Dew Point
Distillation
Humidity
Hygrometer
Rain
Refrigeration
Saturation
Steam
Sublimation
Transpiration
Vapor
Water

EVARTS, WILLIAM (1818-1901), an American lawyer, gained recognition for successfully handling important trials. He was largely responsible for President Andrew Johnson's acquittal in his impeachment proceedings in 1868 (see JOHNSON, ANDREW [The Impeachment Proceedings]). Evarts served as Attorney General of the United States in 1868 and 1869. As president of the New York City Bar Association, he led movements for law reform and helped smash the "Tweed Ring" (see TWEED, WILLIAM MARCY). His famous closing argument for the defense in a case against Henry Ward Beecher lasted eight days in court. Evarts was born in Boston.

DANIEL J. [illegible]

EVE. See ADAM AND EVE.

EVELYN, *EEV lin*, **JOHN** (1620-1706) was an English writer. His diary described important personalities of his time and told of his travels on the European continent. He also wrote works on gardening, forestry, and architecture. Evelyn was born at Wotton, Surrey. He studied at the Middle Temple and Oxford University. He helped found the Royal Society and became its secretary in 1672 (see ROYAL SOCIETY). Evelyn held minor government offices. He supported the king and the Church of England.

ARNOLD WILLIAMS

EVENING PRIMROSE is any one of several related wild flowers that grow from Labrador to Florida and westward to Wyoming and New Mexico. The plants may be 1 to 6 feet high, and often have shrubby bases. The hairy leaves grow 2 to 6 inches long. Saucer-shaped flowers grow among the upper leaves. They may be white, bright yellow, or rosy pink. The blossoms may be 1 to 4 inches wide. But one species, called the *small-flowered* evening primrose, has flowers that grow only ½ inch wide, or smaller.

Scientific Classification. Evening primroses belong to the family *Onagraceae*. The common one is genus *Oenothera*, species *biennis*. The small-flowered plant is classified as *O. cruciata*.

GEORGE H. M. LAWRENCE

See also GODETIA.

EVENING SCHOOL. See NIGHT SCHOOL.

EVENING STAR is a planet which can be seen in the sky after sunset. The term particularly applies to Venus and Mercury. When they lie west of the sun and can be seen just before sunrise, they are called *morning stars*. They are not really stars, but members of our own solar system. They shine by reflecting sunlight. But the ancients thought of planets as wandering stars. They called Venus either *Hesperus* or *Vesper* as an evening star, and *Phosphorus* or *Lucifer* as a morning star. They called Mercury by its present name as an evening star, but *Apollo* as a morning star. See also MERCURY (planet); PLANET; VENUS (planet).

CHARLES ANTHONY FEDERER, JR.

EVEREST, SIR GEORGE. See MOUNT EVEREST.

EVEREST, MOUNT. See MOUNT EVEREST.

EVERETT, Mass. (pop. 43,544; alt. 10 ft.), is a residential and industrial center just north of Boston. It lies on the banks of the Mystic River. For location, see MASSACHUSETTS (color map).

Everett has much heavy industry, including a refinery and a chemical plant. The city's products include cans, cast-iron pipe, chemicals, coke, gasoline and petroleum products, and greeting cards. It also makes jet engines, mattresses, paints, office duplicators, restaurant equipment, shoes, and steel castings. Bulk cargoes arrive in the city on ships.

The city was settled in 1643. It became a town in 1870 and a city in 1892. It was named for statesman Edward Everett. It has a mayor-council type of government.

WILLIAM J. REID

See also EVERETT, EDWARD.

EVERETT, Wash. (pop. 40,304; alt. 20 ft.), is a seaport and lumber and railroad center on Puget Sound, about 30 miles north of Seattle (see WASHINGTON [map]). Its wide streets and business district were laid out in 1892. Wood pulp, paper, plywood, lumber, and shingles are its most important manufactured products. Other industries include fishing, an ironworks, and a stove factory. The Great Northern Railway and a transcontinental highway lead east from Everett through Stevens Pass in the Cascade Mountains. Everett has a commission government.

HOWARD J. CRITCHFIELD

EVERETT, EDWARD (1794-1865), an American statesman, was considered one of the greatest orators of his day. He was the chief speaker at Gettysburg, Pa., on Nov. 19, 1863, the day that Abraham Lincoln delivered his 267-word Gettysburg Address (see LINCOLN, ABRAHAM [Gettysburg Address]). Everett was so amazed at Lincoln's logic and ability to say so much in so few words that he declared Lincoln's speech would live for generations while his own would be forgotten.

Brown Bros.

Edward Everett

Everett was born in Dorchester, Mass., on April 11, 1794. At 19, he became a Unitarian minister, but resigned from his first pastorate in less than two years. He studied in Germany and England, and returned to become professor of Greek literature at Harvard College. For four years, he was editor of the *North American Review*. Then he served five terms in Congress. He was governor of Massachusetts from 1836 to 1840, United States Minister to Great Britain from 1841 to 1845, and president of Harvard from 1846 to 1849. In 1852, he became Secretary of State in President Millard Fillmore's Cabinet. Soon after, Everett was elected U.S. Senator from Massachusetts. He resigned in 1854. In 1860, he was candidate for Vice-President for the Constitutional Union party (see CONSTITUTIONAL UNION PARTY).

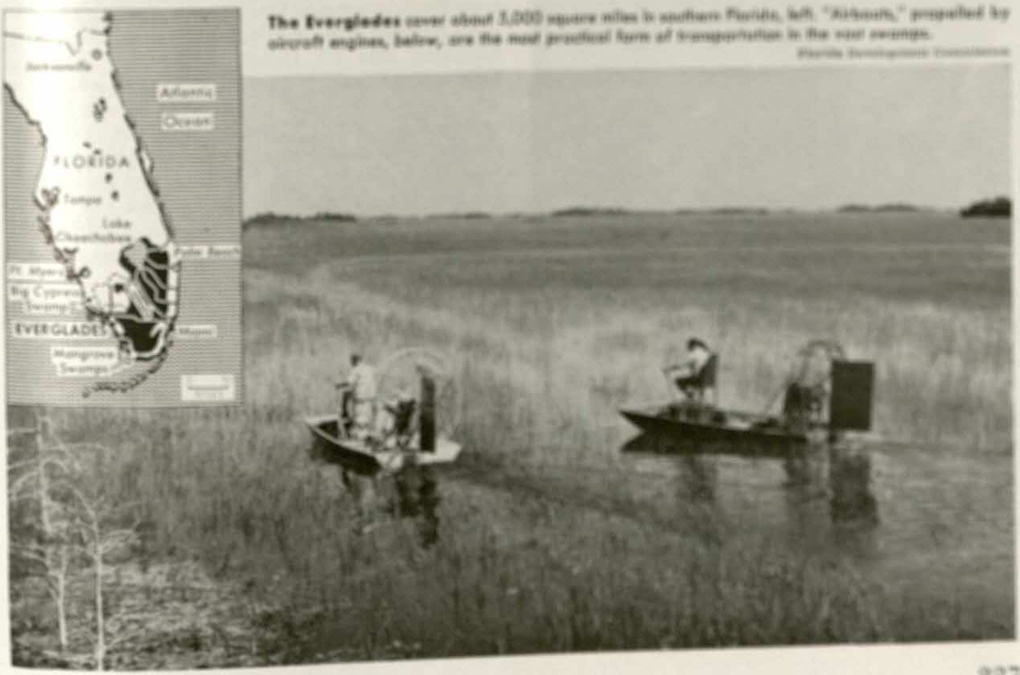
W. B. HESSELTINE

EVERGLADE STATE. See FLORIDA.

EVERGLADES is one of the largest and most interesting swamp areas in the world. The Everglades cover more than 5,000 square miles in the southern part of Florida. They reach from Lake Okeechobee south almost to the tip of the Florida peninsula. Arms of the Everglades extend around the eastern and western sides of the lake. Then the swamps stretch southward in a sweep about 40 miles wide and 100 miles long, merging into salt water marshes and mangrove swamps near the Bay of Florida and the Gulf of Mexico. For location, see FLORIDA (color map). The northern and eastern parts of the Everglades are plains covered by sawgrass that grows as high as 12 feet. Wax myrtles, willows, bays, and custard apples grow on clumps of higher lands called "tree islands." The soils of the Everglades are made up largely of layers of muck and peat, which are the remains of decayed plant life, and of gray marl.

The low basin which makes up the Everglades region was once the bottom of a sea. During the Ice Age, the region was alternately flooded with sea water and drained, as the ice sheets advanced and retreated. When the last ice sheet retreated, the sea rose and flooded the outlets of Everglades streams.

The Everglades were uninhabited until 1842, when the Seminole Indians fled to the area after wars with



The Everglades cover about 5,000 square miles in southern Florida, left. "Airboats," propelled by aircraft engines, below, are the most practical form of transportation in the vast swamps.

Florida Development Commission

United States troops and white settlers of Florida. See Seminole Indians.

In 1906, the state of Florida began draining large areas of the Everglades to make the rich muck suitable for farm land. Canals were built from Lake Okeechobee to the ocean. Sugar cane and vegetables were grown. But the dry muck caught fire easily, and salt water crept from the ocean into wells. In 1948, the federal government approved a plan and authorized a fund for scientific reclamation to overcome these difficulties. In 1947, the southwestern part of the region became the Everglades National Park. Garald G. Parker

See also Everglades National Park; Indian, American (color picture, Seminole Indians); Lake Okeechobee.

EVERGLADES NATIONAL PARK covers 1,400,533 acres on the southwestern tip of the Florida peninsula. It includes Ten Thousand Islands along the Gulf of Mexico and parts of the Everglades and the Big Cypress Swamp. It is one of the few subtropical regions in the United States. The junglelike plant life includes delicate orchids, lacy cypress trees, pines, palms, and mangrove trees that grow as high as 70 feet. Crocodiles, alligators, manatees, huge turtles, and many swamp birds live there. The Anhinga Trail, named for the American snakebird, is a boardwalk that extends into the jungle. The creeks and rivers abound in fresh-water fish. The park was dedicated in 1947. Garald G. Parker

EVERGREEN is a plant that remains green throughout the year. It grows new leaves before shedding the old ones. Many evergreens keep their leaves for several years. The leaves of some of them are tougher and more leathery than those of other plants. Some evergreens, such as the cone-bearing trees, have needle-shaped leaves. These leaves have less surface than broad, flat leaves, and can resist changes in temperature more easily. Many tropical plants are called broadleaf evergreens to distinguish them from the needle-leaved ones. Both kinds of leaves contain *chlorophyll*, the green coloring matter that is used by plants to manufacture food.

The best-known evergreen trees include pine, fir, spruce, hemlock, cedar, cypress, and yew. Holly, box, ivy, and myrtle are other common evergreens. Rhododendron, laurel, some magnolias, and most tropical plants are evergreens. Some evergreens, such as pines, are valuable timber trees. Richard J. Preston, Jr.

These Evergreen Trees have tough, needle-shaped leaves that withstand frost and drying winds. They stay green all year.

FPG

Related Articles in World Book include:

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Ivy
Juniper
Laurel
Magnolia
Myrtle
Pine
Redwood
Rhododendron
Sequoia
Spruce
Tree (Kinds)
Wax Myrtle
Yew

EVERGREEN STATE. See Washington.

EVERLASTING FLOWER is a name for various strawy flowers that can be kept for some time after they are picked and dried. Most of these flowers are members of the daisy family. But one of the best known is the *globe amaranth*. Others are *immortelle* and *strawflower*. The dried flowers of these plants are popular for use in winter bouquets. Robert W. Schery

See also Amaranth; Immortelle; Strawflower.

EVERYMAN is an English morality play written in the 1400's or 1500's. Its author is unknown. In the play, good and evil forces struggle to possess Everyman's soul. God sends Death to summon Everyman on a pilgrimage. He is not prepared to go, but Death will not let him delay. Everyman asks his friends, Fellowship, Kindred, Cousin, and Goods, to go with him. They refuse. He asks Good Deeds, but she is too weak because he has neglected her. When Everyman prays for God's forgiveness, she becomes strong enough to join him. Knowledge, Discretion, Strength, Five Wits, and Beauty also join him, but one by one they forsake him. Only Good Deeds remains as Everyman goes to heaven. Hugo von Hofmannsthal wrote a German version. George A. Wickes

See also Morality Play.

EVIDENCE is that which tends to prove or disprove the existence of something. The things that human beings see, feel, hear, taste, or smell are spoken of as the evidence of the senses. Some things are considered true without evidence to prove them. For example, the Declaration of Independence states "We hold these truths to be self-evident . . . ."

In law, the parties to a legal dispute submit evidence to the *trier of fact* to enable it to decide a disputed question of fact. The trier of fact in a jury case is the jury. In a nonjury case, the trier of fact is the judge. The eloquent argument of a lawyer may influence the decision, but it is not evidence. Evidence in court usually consists of the testimony of witnesses. But it may also consist of documents such as letters, or tangible articles such as a murder weapon.

Kinds. Evidence may be *direct* or *circumstantial*. Direct evidence does not require any reasoning process or inference to apply it to the question to be decided. The testimony of an eyewitness to a murder is direct evidence. Circumstantial evidence is not direct, but points to a particular conclusion. For example, in a murder case, evidence that the accused person bought a gun shortly before the shooting would be some indication of his guilt. But it would not be sufficient by itself to prove his guilt.

Rules govern the admission of evidence at a trial. Each party offers the evidence to prove his side of the case. Such evidence is admitted unless the opposite party objects. In that case, the judge decides whether or not it is admissible under the rules. After evidence has been admitted, the trier of fact decides what weight to give it. But if the evidence is all one way or the other, the judge may direct the jury on what kind of verdict to return.

Relevancy. Evidence must be *relevant*. That is, it must relate to a question in the case and be of help in deciding it. Relevancy arises as a problem only in connection with circumstantial evidence. For example, a case may involve an automobile collision in which a son drove his father's car. The father may be liable if he consented to the driving. Evidence that the father had always consented at other times would make it more probable that he had consented this time. The evidence would be relevant.

Sometimes, evidence that seems to be relevant is kept out because it would be misleading. For example, in criminal cases, evidence that the accused person committed other crimes or, generally speaking, has a bad character, is not admitted. It may be true that criminals are more likely to commit other crimes. But the jury has to decide whether the accused committed this *particular* crime. They cannot send him to prison merely because he is an undesirable person.

Privilege. Evidence may be excluded because of a *privilege*. A privilege is a right to keep evidence from being admitted in order to protect some interest or relationship. Because a privilege helps to prevent disclosure of the truth, the interest or relationship being protected must be very important. The United States Constitution has created some privileges, such as the privilege against unreasonable search and seizure and the privilege against self-incrimination (see United States Constitution [Amendment 4 and Amendment 5]). Other privileges recognized by law include confidential communication between husband and wife, confidential communication between attorney and client, and offers to compromise a claim. Some states recognize a privilege for communications between doctor and patient, and others recognize a privilege for a journalist not to have to disclose the source of his information.

Direct Examination and Cross-Examination. Witnesses generally give their testimony in response to questions asked by the attorney. This practice gives the opposing attorney a chance to object if he believes that the answer will not be admissible under the rules of evidence. It also helps the witness to tell his story in an orderly manner, and keeps him from going into matters that are not relevant.

The jury must know whether witnesses are accurate and truthful. Therefore, witnesses are sworn to tell the truth and may be cross-examined by the other side in an effort to break down their testimony. Witnesses may be *impeached*, or shown to be unworthy of belief. For example, an attorney may show that a witness is related to the accused and therefore probably biased in that person's favor. Or, it may be shown that, at an earlier time, the witness told a story different from his testimony on the witness stand.

Hearsay Rule. The importance of cross-examination gives rise to the rule against admitting *hearsay*. Hearsay is a statement made out of court and offered in court by someone else to prove the truth of whatever was asserted in the statement. For example, to prove that Henry was driving the car, George is called to the witness stand to testify, "William told me that Henry was driving the car." George cannot be cross-examined to find out if Henry was actually driving the car, because he does not know. He can only be cross-examined as to whether he is reporting accurately what William said. The real witness, in the accuracy of whose story we are interested, is William, and he is not present to be cross-examined. Therefore, William should be called to testify. The "second-hand" testimony of George cannot be admitted as evidence in a court, because what he has to say is hearsay.

There are many exceptions to the hearsay rule. Such exceptions are based on situations where the courts believe that the statements quoted are truthful, despite the absence of cross-examination. One such exception is the *dying declaration*, where a murder victim, knowing he is about to die, names his assailant. The reason for the exception is that persons who know they are about to die are believed to tell the truth. Other exceptions include public records and business records, because they are likely to be accurate.

Presumptions. When evidence on a particular fact is missing, the law may say that the point is proved by evidence of other facts. This is called a *presumption*. For example, proof that a person has been absent seven years without his family hearing anything about him gives rise to the presumption that the person is dead. Proof that a letter was properly addressed, stamped, and mailed gives rise to the presumption that it was received by the person to whom it was sent. Presumptions may be based on experience or on the desire to obtain a just result even though evidence is lacking.

Some rules of evidence have been criticized for being too technical. This criticism is often justified, but the rules generally work well and they most often lead to good results. Edward W. Cleary

EVIL. See Good and Evil.

EVIL EYE is the name used for a superstitious belief that some people can cause harm just by looking. This strange belief has existed for thousands of years in many parts of the world, and still has followers in southern Europe and the Middle East. Believers use many kinds of charms to counteract the effects of the evil eye. They may recite magic words, point with a prong of coral or their outstretched fingers, or wear charms, such as a string of blue beads. John Mulholland

See also Amulet; Exorcism; Superstition (Protection by Charms).

EVOLUTION, in mathematics. See Involution.

EVOLUTION. In everyday language the word evolution means almost any kind of orderly development. Thus we say that buds evolve into flowers, or that modern automobiles have evolved from "horseless carriages." Even scientists, who often use common words in special ways, mean orderly development when they describe the evolution of climates, islands, continents, planets, or stars.

In most scientific books, however, the word means *organic* evolution, or the *theory of evolution* applied to living things. This theory says that plants and animals have changed through generation after generation and still are changing today. Since this change has been going on for ages, all things that now live on earth are much-changed descendants of others that lived thousands and even millions of years ago.

The Theory of Evolution

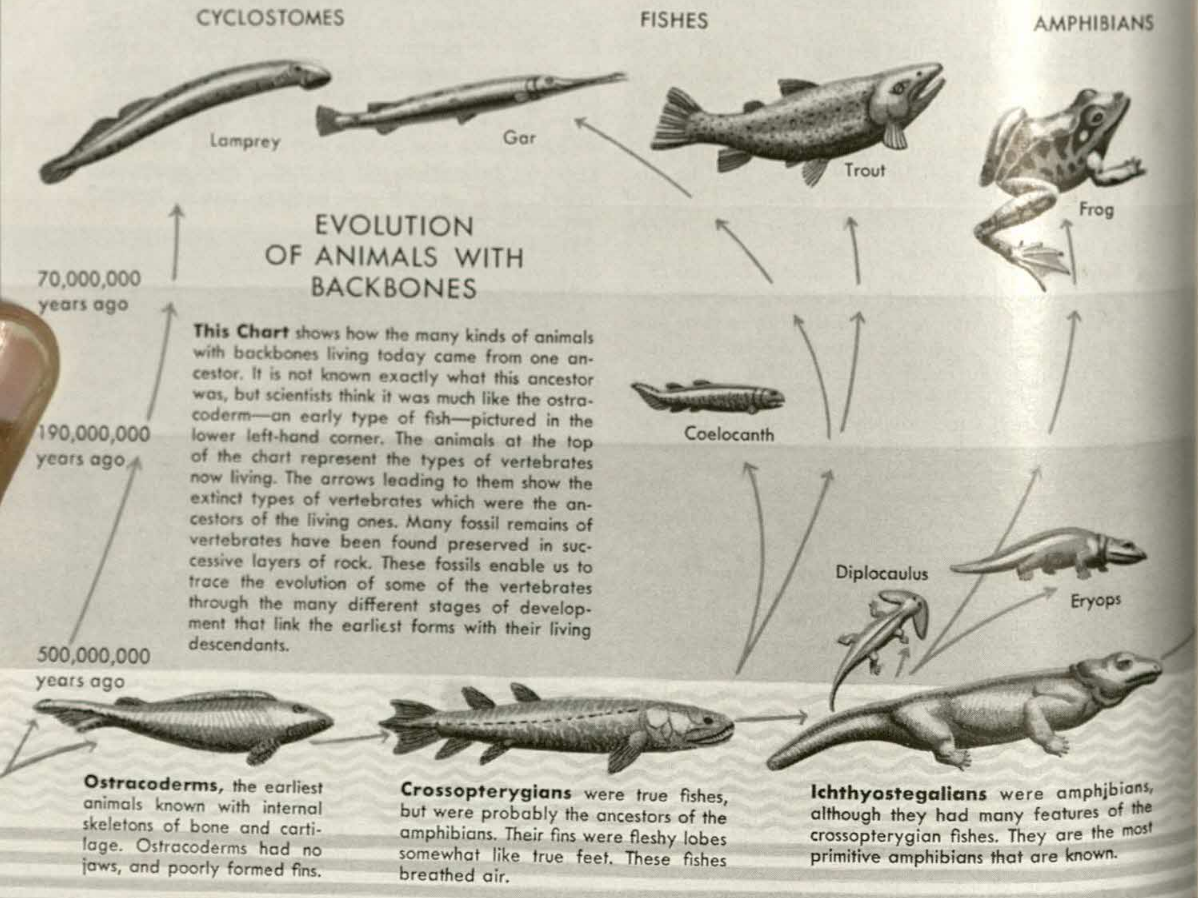
The theory of evolution includes all we know or can reasonably conclude about this age-old process. It describes changes and undertakes to explain them. It traces their effects. It shows how these changes followed one after another, and how they produced new kinds of living things whose descendants became more and more different from their ancestors. Most of those new types were more complex and efficient than earlier ones, and so we often say that evolution deals with the progress as well as the development of differences between plants and animals. Perhaps we should add "and other groups," because evolutionary changes seem to have produced things which are neither animals nor plants, although they are related to both.

The theory of organic evolution involves these three main ideas:

(1) Living things change from generation to generation, producing descendants with new characteristics.

(2) This process has been going on so long that it has produced all the groups and kinds of things now living, as well as others that lived long ago and have died out, or become extinct.

(3) These different living things are related to each other, and so are the families or larger groups of which



EVOLUTION OF ANIMALS WITH BACKBONES

This Chart shows how the many kinds of animals with backbones living today came from one ancestor. It is not known exactly what this ancestor was, but scientists think it was much like the ostracoderm—an early type of fish—pictured in the lower left-hand corner. The animals at the top of the chart represent the types of vertebrates now living. The arrows leading to them show the extinct types of vertebrates which were the ancestors of the living ones. Many fossil remains of vertebrates have been found preserved in successive layers of rock. These fossils enable us to trace the evolution of some of the vertebrates through the many different stages of development that link the earliest forms with their living descendants.

Ostracoderms, the earliest animals known with internal skeletons of bone and cartilage. Ostracoderms had no jaws, and poorly formed fins.

Crossopterygians were true fishes, but were probably the ancestors of the amphibians. Their fins were fleshy lobes somewhat like true feet. These fishes breathed air.

Ichthyostegalians were amphjbians, although they had many features of the crossopterygian fishes. They are the most primitive amphibians that are known.

these living animals or plants are members.

Let us suppose that in ancient times some very simple one-celled creatures began to evolve, or change. Some of these creatures produced new members of their own groups—members with corkscrew-shaped bodies, hair-like projections, or other characteristics still found in bacteria. Some evolved differently. They lost certain parts and added others until they produced at least one new group which sometimes is known as the *protists*. Certain protists then evolved into plants, while others produced descendants that became simple animals. The whole process of evolution may be represented by a diagram which somewhat resembles a tree. It shows how group after group branched off, and it shows that every branch is related to the others.

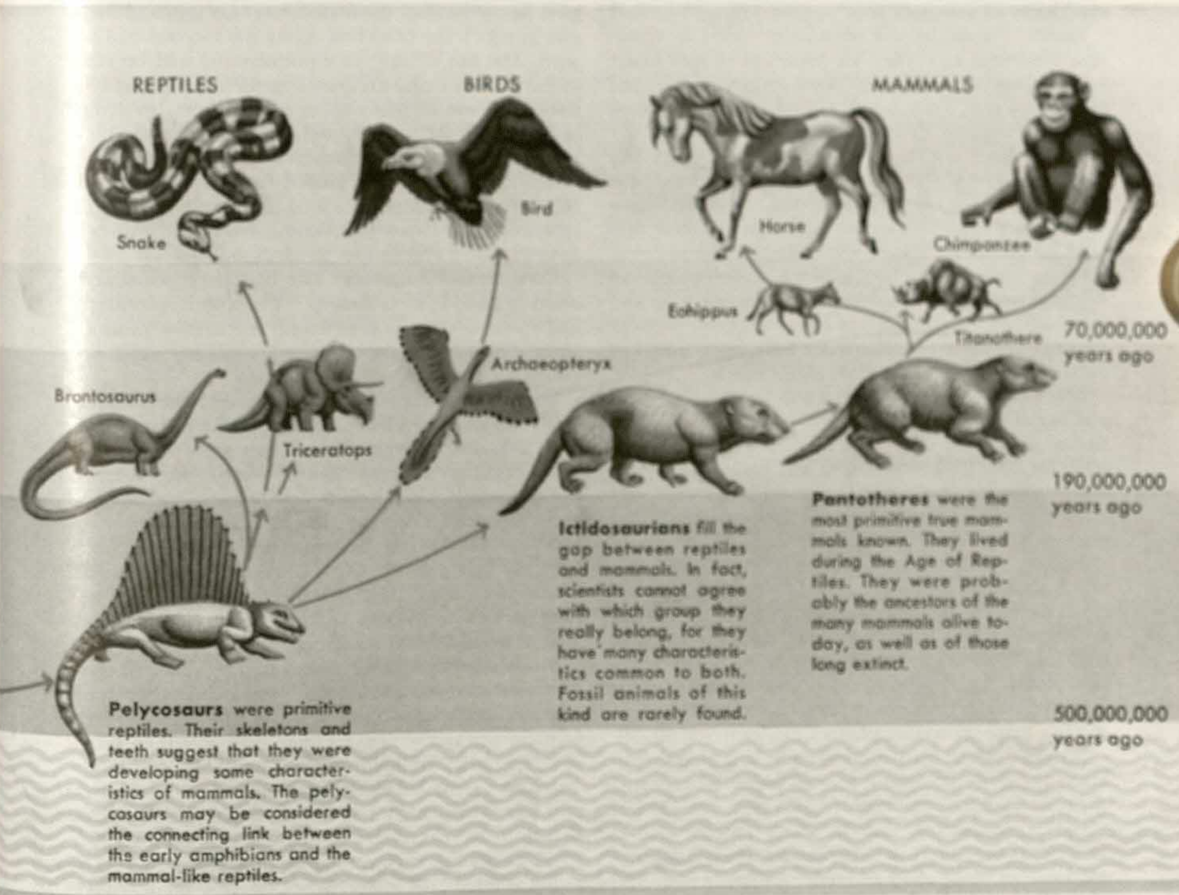
Relationships may be traced much further, for evolution did not stop when plants and animals appeared. Plants and animals also began to change. They branched into such groups as green seaweeds, flowering plants, insects, and backboned creatures, or vertebrates. These evolved and branched still further into groups of species which are so plainly related that we call them families. The pine, mosquito, and horse families are well-known examples.

The Evidence for Evolution

Belief in evolution is based on several quite different kinds of evidence. Five of these kinds of evidence are discussed below because they show the chief bases on which the whole theory of evolution now rests.

Variation and Change. Everyone knows that living things vary. Two trees are never exactly alike. Not all kittens born to the same cat in the same litter are alike. Flowers of several colors may grow from a single packet of seed. Are such variations part of evolution? Do they ever produce something new?

The first question is not easy to answer, for not all variations are alike. Some are called acquired characteristics, and are caused by outside conditions — by warm weather, rich soil, special food, and so on. As far as we know, ordinary acquired characteristics are not inherited. This means that they cannot be passed on



Pelycosaurs were primitive reptiles. Their skeletons and teeth suggest that they were developing some characteristics of mammals. The pelycosaurs may be considered the connecting link between the early amphibians and the mammal-like reptiles.

Ictidosaurians fill the gap between reptiles and mammals. In fact, scientists cannot agree with which group they really belong, for they have many characteristics common to both. Fossil animals of this kind are rarely found.

Pantotheres were the most primitive true mammals known. They lived during the Age of Reptiles. They were probably the ancestors of the many mammals alive today, as well as of those long extinct.

from one generation to another. If that is true they cannot help in the process of evolution.

Many other variations can be passed on, yet they may not produce any change. The article HEREDITY describes smooth yellow peas that produced four kinds of offspring and would go on doing so as often as they were grown. But that article also tells how breeders use just such variations to develop useful types of plants and domestic animals. Such new types are examples of evolution on a small and very special scale.

Some variations, however, go much further. In 1849, for example, a wild grapevine suddenly produced big, sweet grapes which were named Concord. Other *sports*, or *mutations*, as such variations are called, have produced hornless cattle, short-legged sheep, "double" flowers, and new varieties of seeds.

A different sort of variation takes place when two kinds, or *species*, cross and produce a new one. This has happened at least twice among horse chestnuts, as well as in hemp nettles, grasses, roses, and some snails. One new grass which developed from a cross grew so fast and so tall that it crowded out both its parent species. This was progressive evolution, for the new form was superior to its ancestors.

Fossils. Fossils are the remains or traces of things that lived ages ago. They are preserved in rock layers called strata which lie one upon another, much like boards in a pile. These layers formed one after another, from very ancient to modern times. When fossils are collected from one layer they reveal variations like those shown by plants and animals today. When fossils from other strata are studied in turn, those variations often form series which record the stages by which new or larger groups developed while old ones disappeared. Thus sea urchins at the bottom of the chalk formation in England were followed by others that became more and more different until four new kinds left their shells in the topmost strata. Similar series have been traced in fossil corals, snails, lamp shells and scallops.

Many changes are shown in a series of petrified teeth and bones. One series begins with creatures about the size of a fox and ends with modern horses. Another series begins with piglike beasts and continues step by step to gigantic elephants. This series had several side branches, one of which includes the mastodons that roamed North America thousands of years ago.

Finally, fossils show still greater branching series which start with simple forms of life found in very ancient rocks. From such beginnings there is gradual development into more and more complex forms in later and later strata. Thus seaweeds appeared before land plants. Ferns and horsetail rushes were followed by plants related to pines which lived on earth for millions of years before flowering plants developed.

Scientists admit that this evidence is not complete. Many things lived without leaving fossils. Many types of fossils have not yet been found. Still, the general record is convincing and indicates orderly change throughout the history of living things. It also indicates relationships, since older and older fossils are more and more alike. If these fossils were arranged on a diagram, they would lie close to the place where one group branches into two or three. See FOSSIL.

Embryology. Much evidence for our ideas of evolution comes from the development of individual living things, especially animals. Such development is much like stages through which large groups of animals have passed during the earth's long history.

Let us take two examples. Facts from fossils, plus other data, have shown that mammals (animals which have solid bones, warm blood, and lungs that breathe air, and nourish their young with milk) form the last stage in a long evolutionary series of development. This series began with little sea-dwelling creatures which had gristly rods instead of backbones. Today an unborn mammal, such as a dog, develops that same gristly rod, next gets a backbone of cartilage, and then turns the cartilage into bone. While this is being done, the embryo develops gills like a fish, loses them, and builds up two lungs. At the same time, the dog's heart develops through fish, amphibian, and reptilian stages until it becomes the four-chambered organ which pumps blood so efficiently that the animal can keep warm.

Our second example is a group of catfish found in India. Their ancestors must have lived in water and breathed with gills. These special fish often wriggle out on land, where they breathe by means of branched organs that do the work of lungs. Yet the young catfish goes through a stage in which it has only gills and then one in which the branched organs are too small to be used. The fish cannot come out of water and breathe its oxygen from air until these structures approach their full size. There are many examples like these, involving bones, shells, soft organs, and so on. They show that present-day animals go through the same stages of development which groups passed through ages ago. In other words, characteristics long lost by adults still are inherited. This means that there is real relationship between modern and earliest forms of animals.

Comparative Anatomy. The bodies of plants and animals provide facts dealing with both relationships and changes. They do so especially when different structures of their bodies are compared, a method which explains the term *comparative anatomy*.

Suppose we compare a human arm with the front leg of an alligator and a horse, the flipper of a whale, and a bat's skin-covered wing. At first they seem utterly different. Yet they actually show the same arrangement of bones, muscles, blood vessels, and nerves. This arrangement, moreover, can be traced in salamanders and newts, whose forelegs are so primitive that the bones have not yet hardened. More advanced creatures, from alligators to man, have inherited the salamander arrangement with changes which produce better legs as well as arms, flippers, or wings.

Strata more than two hundred million years old contain fossil animals called amphibians because they lived both on the land and in the water. The legs and feet of these animals were even more primitive than those of salamanders. Still older beds contain fishes with fins strengthened by bones arranged like those in the feet and legs of amphibians. Comparison shows this resemblance to be real. Bones can be traced from fossil fish to amphibian, and then to arms, flippers, and wings of living animals. In other words, several groups have inherited the bone arrangement of those ancient fishes, with changes which turned what once were fins into structures that seem quite different.

Comparative anatomy also explains the origin of structures which now are small and useless. Some snakes, for example, have clawlike appendages which prove to be remains of hind legs that have almost disappeared. Splint bones in the forelimb of a modern horse are remnants of toes which grew to full size in certain ancient horses. Man's appendix is all that is left of an intestinal organ which has reached its greatest size and value in plant-eating animals such as kangaroos and rabbits. Similar organs in plants include the leaves of cactus plants. These leaves are tiny things that drop off as the prickly spines develop. Comparison shows that some of these spines themselves are leaves.

Geographic Distribution. Much evidence of evolution comes from plants and animals that live on islands far from continents. The Galápagos Islands, for example, lie 500 miles from South America, and are surrounded by the deep Pacific Ocean. They have twenty-six kinds of land birds, all resembling species found in western South America. But twenty-three of these species seem to have changed since they reached the islands, for the Galápagos birds are distinct species. Comparable differences are shown by lizards and tortoises, of which there were eleven species on as many different islands. They apparently developed these because of changes that took place after their ancestors drifted from the mainland of South America.

Australian animals reveal a different situation. Both strata and fossils show that Australia was separated from Asia at a time when mammals were primitive creatures related to opossums. As ages passed, new groups of animals developed, while most of the primitive types disappeared. But these new forms could not get to Australia, where the opossum-like creatures (marsupials) varied in their own special ways. In time the original types of marsupials were replaced by animals such as the wombats, the kangaroos, and the koalas, which look like teddy bears. Their development can be traced in fossils, which record the history of animals in Australia from ancient to modern times.

This record supports all three main ideas in the theory of evolution. Fossils in successive strata show variations and changes. These changes accumulated until the descendents of opossumlike creatures became kangaroos, wombats, or koalas. The process went on through sixty million years. It produced dozens of species now living, as well as others that have died out. Finally, since none of these forms could come from other regions, all must be descended from ancient Australian mammals. This means that all the kinds of kangaroos must be related, and so on through other groups.

History of Evolution

Early Theories. As the facts of evolution were discovered, men undertook to explain them. Some of the first modern attempts were made by Erasmus Darwin, an English physician, and Comte Georges de Buffon, of France. Both men, who wrote during the middle to late 1700's, placed emphasis on what are now called acquired characters. Strong sun, they said, made desert animals pale. Blows or injuries had forced skin to develop thick armor. Kneeling for burdens gave camels thick pads upon their knees. They believed that such new characteristics were inherited, and therefore caused evolution to proceed at a rapid rate.

These men were followed by Jean Baptiste de Lamarck, a Frenchman, who in 1809 published a book called *Zoological Philosophy.* Lamarck agreed in part with Buffon and Darwin, but he put special emphasis upon the "will to change." According to him, giraffes got long necks by *wanting* to reach for leaves on tall trees and the ancestors of ducks developed webbed feet by *attempting* to swim. But when organs were not used they soon dwindled to mere vestiges. Great changes, such as those from reptile to mammal, were caused by a "perfecting principle" which Lamarck did not try to explain.

These ideas had little effect and are not generally accepted today. Modern explanation of evolution dates from 1859, when Charles Darwin, the grandson of Erasmus Darwin, published *The Origin of Species by Natural Selection.*

Darwin's Theory. Charles Darwin began with the fact that variations exist on such a scale that no two living things are exactly alike. He next showed that living things increased in number far more rapidly than people realized. In fact, living things reproduce in numbers so great that earth cannot provide room and food for all their abundant offspring. Members of each species therefore compete with each other for a chance to live, as well as with members of different species. In this competition any helpful variation gives its owner an advantage over neighbors that are not so well adapted. Individuals with such variations therefore will win the struggle for existence. They will live and reproduce, while forms not so well equipped will die.

Darwin called this process *natural selection,* or the "preservation of favored races in the struggle for life." He compared it to artificial selection. In this process breeders choose plants or animals with useful variations, and save and breed them through many generations. They produce new varieties as distinct as cabbage and cauliflower, or poodle and mastiff. Natural selection, said Darwin, could go much farther. By working for ages, natural selection could produce even the biggest and most distinct groups found in the living world.

At the time Darwin wrote, no one knew much about the nature of variation or heredity. He described such variations as the Concord grape. He did not distinguish these variations from acquired characters mentioned by his grandfather and by Buffon. According to Charles Darwin, all variations belonged to one general class and might be inherited.

Later Studies showed that this was not true. Mutations, or *sports,* and many other characters are inherited, but most acquired characters are not. The difference lies in heredity itself, which is a precise and often a complex process. It depends upon exceedingly small particles called *genes,* which are arranged in microscopic structures known as *chromosomes* (see HEREDITY). Genes and chromosomes are found in the reproductive cells of plants or animals. These cells divide and go from one generation to the next, carrying genes which produce old or new hereditary traits. Changes produced by genes, therefore, are passed on, but those caused only by outside conditions are not.

Modern studies of evolution have shown that inheritable variations arise in at least three ways. Many develop because genes change. Such changes produce characters such as pinkish eyes in red-eyed flies or short vines among descendants of peas whose vines are tall. Other variations appear when chromosomes with their sets of genes make new combinations. This often happens when breeders cross different varieties or species. Still greater changes take place when chromosomes are doubled or when sets of chromosomes are repeated in the process of reproduction. Many double flowers have been produced by this process.

Changes such as these are produced in great numbers. Some of them appear over and over again. Most authorities agree that they provide all the "raw material" needed for evolution, with no help from acquired characters.

Most authorities also agree that natural selection has controlled the results of inherited variations, just as Darwin supposed. That is, selection has preserved those living things which had new, helpful characters. It has helped them to crowd out neighbors which either lacked those advantages or developed harmful variations. When the new forms reproduced, the process was repeated, and so on through countless generations. Since the earth offers all sorts of places and conditions for life, this process may have produced things as different as seaweeds, insects, and men. Fossils in ancient strata show that life has been changing for at least fifteen hundred million years.

Unsolved Problems of Evolution

Although general facts and conclusions about evolution seem clear, the subject still presents many unsolved problems. The most important of these can be grouped under three headings:

The Cause of Variations. Experiments have shown that genes can be changed by some chemicals and by radiations such as X rays. Other chemicals upset the arrangement of chromosomes. These experiments, however, are artificial. A great deal still must be learned about the cause or causes of variations in nature, where man cannot interfere.

Guiding Forces of Evolution. Some authorities think that natural selection guides *all* evolution, but these authorities need much more knowledge on how selection works. Some authorities think that other factors are involved—that living things may change in special ways, or that whole races grow old as individuals do.

Missing Evolutionary Links. Many links between groups are still living. Others are known from fossils. Yet there still are numerous gaps in the series, especially between groups that evolved very long ago.

Beside these, there are hundreds of smaller problems which deal with the evolution of special groups, with their relationship to their surroundings, and with the length of time needed for one group or another to change. No one should make the mistake of saying that evolution is fully understood.

Objections to the Theory of Evolution. Many persons object to the theory of evolution because it conflicts with their religious beliefs. The religious objection to evolution stems from at least three convictions:

1. A conviction regarding the Bible. Many persons believe the account of Creation in the Book of Genesis to be a historical fact. Hence it is considered that God not only made the world by separate Almighty acts, but that He also created man, animals, and plants in such a way that they only would "yield fruit after their kind." Persons who hold this conviction usually do not believe in evolution from lower forms.

2. A conviction regarding God. In the Bible, God is held to be the Creator, the Sustainer, and the Ultimate End of all things. Many Christians believe that it is impossible to reconcile this conviction with the idea that evolutionary development has been brought about by natural forces present in organic life.

3. A conviction regarding the Gospel of the Christian religion. The reality of sin, and of redemption from sin, is held to be essential to the Christian faith. But if man is in the process of evolving from a lower state, sin tends to become mere imperfection, and the Gospel of redemption from the guilt of sin tends to lose all meaning.

Some persons also object to the theory of evolution on scientific grounds. Scientists themselves have disagreed on certain facts about evolution. The opponents of evolution say that in view of these disagreements the theory is far from being proved. It is denied that the facts of fossil arrangement, of comparative anatomy, of embryology, and so on, are evidence for the descent of species. Most scientists believe, for example, that the fact that the vertebrates all have many structures on the same plan proves that vertebrates all evolved from some common lower ancestor. But the opponents of the theory believe that this fact merely indicates that the Creator used the same pattern in making species of the same class.

CARROLL LANE FENTON

Related Articles in WORLD BOOK include:

Biogenesis
Biology
Breeding
Darwin, Charles R.
Haeckel, Ernst H.
Heredity
Lamarck, Chevalier de
Mutation
Natural Selection
Prehistoric Animal
Prehistoric Man
Wallace, Alfred R.
Weismann, August
Wright, Sewall

Outline

I. **The Theory of Evolution**
II. **The Evidence for Evolution**
  A. Variation and Change
  B. Fossils
  C. Embryology
  D. Comparative Anatomy
  E. Geographic Distribution
III. **History of Evolution**
  A. Early Theories
  B. Darwin's Theory
  C. Later Studies
IV. **Unsolved Problems of Evolution**
  A. The Cause of Variations
  B. Guiding Forces of Evolution
  C. Missing Evolutionary Links
  D. Objections to the Theory of Evolution

Questions

What does the word *evolution* mean?

What three ideas are basic to the theory of organic evolution?

Why are fossils important in the study of evolution?

In what way does a catfish found in India show a link between modern and early forms of animals?

How does comparative anatomy provide scientists with information about evolution?

What is the process of *natural selection?*

How do genes and chromosomes affect hereditary traits?

What are two objections to the theory of evolution?

Why is Charles Darwin important in evolution?

EWELL, RICHARD STODDERT (1817-1872), was a Confederate general. He led a division under "Stonewall" Jackson in the famous Shenandoah Valley campaign of 1862, distinguishing himself at Winchester, Strasburg, and particularly at Cross Keys. He aided Jackson in the defense of Richmond, and fought in the Seven Days' battles. Ewell participated in the battle of Cedar Mountain and in the second battle of Bull Run (Manassas). At Groveton, on Aug. 28, 1862, he was wounded and lost a leg. He returned to duty in May, 1863, although he had to be lifted to his horse and strapped in the saddle.

Ewell became a lieutenant general and commanded the Second Corps, formerly led by Jackson. Ewell took the corps through the Pennsylvania campaign. He played a controversial role in the battle of Gettysburg. Several of his subordinate officers thought he should occupy Cemetery Ridge. Ewell, apparently taking literally General Robert E. Lee's orders to occupy Gettysburg, refused to seize Culp's Hill (on Cemetery Ridge) on the first day. As a result, Union troops took the hill and used it to anchor the right end of their line. Ewell finally tried to capture the hill, but failed.

Ewell led his corps in the battles of the Wilderness and Spotsylvania Court House. He later commanded the Richmond defenses. When Lee gave up the defense of Petersburg and Richmond, Ewell took command of the remnant of a corps. During the retreat toward Appomattox, Ewell's corps was surrounded and captured at Sayler's Creek, Va. After the war, he returned to his farm near Spring Hill, Tenn.

Ewell was born in Georgetown, D.C., of Virginia parents. He was graduated from the United States Military Academy and fought gallantly in the Mexican War. Although a Union man, Ewell went with the South when Virginia seceded. FRANK E. VANDIVER

EX CATHEDRA. See POPE.

EX POST FACTO is a Latin term meaning *from what is done afterwards*. An *ex post facto* law is one that not only will make a particular act a crime from the time it is passed, but will also punish any person who has already committed the act. In many countries, legislators have had the power to pass such ex post facto laws. Today, they are almost universally condemned. The United States Constitution and state constitutions prohibit such laws. THOMAS A. COWAN

EXCALIBUR, *ehks KAL uh bur*, was King Arthur's sword. One story says that the Lady of the Lake gave him this sword. Another says that only Arthur was able to draw it from a stone in which it was stuck. At Arthur's death, Sir Bedivere threw it back into the lake. A strange hand drew it below, and no one ever saw it again. See also ARTHUR, KING. GEORGE F. REYNOLDS

EXCAVATION, ARCHAEOLOGICAL. See ARCHAEOLOGY.

EXCAVATOR. See BUILDING AND WRECKING MACHINES; STEAM SHOVEL.

EXCESS-PROFITS TAX provided additional revenue for the United States government during three war emergency periods. The government levied a tax on excess earnings of corporations during World War I (1917-1921), World War II (1940-1945), and the Korean War (1950-1953). It also levied this tax on excess earnings of individuals and partnerships in 1917 only. Excess earnings were determined by complex computations. They were earnings that exceeded *either* (1) the average yearly income for certain base years or (2) a fair rate of return on invested capital.

The excess-profits tax was levied in addition to the normal income tax. The tax rate during World War I reached a maximum of 80 per cent on excess earnings. It reached a peak of 95 per cent in 1943, during World War II. During the Korean War, it amounted to 30 per cent. The excess-profits tax has been criticized by many taxation authorities. It has never been continued into normal peacetime periods. CHARLES J. GAA

See also INCOME TAX (Federal Government).

EXCHANGE is the method whereby debts owed in another city or country are settled. *Domestic* exchange consists of postal money orders, express orders, or bank drafts on other cities within the same country. Foreign exchange is in the form of a bill of exchange issued by a bank in one country upon a bank in another.

For example, an importer in New York City or Montreal might owe £1,000 to an exporter in London. He would pay this debt by buying from his bank a check or *bill of exchange* representing £1,000 in a British bank. A bill of exchange is an order, or draft, upon a foreign bank. The importer would be exchanging his dollars for pounds sterling with which to pay his creditor. The price paid for the bill of exchange might be $2.78 per pound sterling. This would be the *rate of exchange*.

The *par of exchange* is the ratio of the gold contents of two currencies. The par of exchange in London before 1931 was determined by dividing the gold in the pound, 113 grains, by the gold in the dollar, 23.22 grains. This set the value of the pound sterling at $4.8665 in American currency. This value has now been greatly reduced.

The rate of exchange between two countries does not necessarily equal the par of exchange. The rate of exchange rises or falls according to the supply and demand for bills of exchange. If New York City debtors to London owe more than London debtors to New York City, a greater demand than supply for sterling exchange results. The rate of exchange in London will rise above par, say to $2.80. This is called being at a *premium*. If the opposite takes place, the rate falls below par, say to $2.76, and would be at a *discount*. When the two currencies are on the gold standard, the rate of exchange varies only within narrow limits, called *gold points*. If the rate rose or fell more, it would be cheaper to ship gold than to buy bills of exchange. When gold cannot be exported, only the demand and supply of bills of exchange determines the rate.

Stable exchange rates help keep the money systems of the world on an even keel. During World War II, the United States and Great Britain kept their rate at $4.03 to the pound. In 1949, Britain devalued its pound and the rate dropped to $2.80. In order to maintain some sort of balance in exchange rates in Europe and in other parts of the world, many other countries lowered the price of their money, too. ROBERT W. MERRY

Related Articles in WORLD BOOK include:

Banks and Banking
Barter
Bill of Exchange
Devaluation
International Monetary Fund
Money

EXCHANGE, FOREIGN. See EXCHANGE; MONEY (table, Values of Monetary Units).

EXCHANGE CLUB, NATIONAL, is a service organization for men which was founded in 1911. It maintains headquarters in Toledo, Ohio, and has a national membership of 87,000. Its activities include community betterment, service to youth, and education in Americanism.

EXCHANGE PROGRAM. See FOUNDATIONS (International Understanding).

EXCHEQUER, *ecks CHECK ur*, is a department in the British Treasury that collects, manages, and disburses government funds. It is a kind of national bank account. The Exchequer is controlled by the Treasury Board, composed of the Prime Minister (called the First Lord of the Treasury), the Chancellor of the Exchequer, and five junior lords. The Chancellor is actually the British financial minister, and is a Cabinet member. He prepares the annual budget, which contains the proposed expenditures of the government and a program for raising money to meet them. The term *exchequer* comes from the old French word *eschequier*, meaning chessboard. It refers to the medieval custom of calculating revenue accounts on a checkered table.
I. J. SANDERS

EXCHEQUER COURT. See CANADA, GOVERNMENT OF (The Courts).

EXCHEQUER DAM is an irrigation and power dam across the Merced River in central California. Completed in 1926, it is 326 feet high and 955 feet wide. The reservoir can hold 281,300 acre-feet of water. The power plant has a capacity of 25,000 kilowatts. The dam irrigates 140,000 acres in the Merced Irrigation District.
T. W. MERMEL

See also DAM.

EXCISE is a tax put on the manufacture, sale, or use of goods. Usually, the state or national government levies the tax on the manufacturer or seller of the goods. But the manufacturer or seller usually adds the amount of the tax to the price of the goods to make the buyer the real taxpayer. In many cities and states, a 3 per cent sales tax is charged on each item purchased. Excise taxes also include fees paid for business licenses. See also SALES TAX.
JOHN ALAN APPLEMAN

EXCITER. See ELECTRIC GENERATOR (How A-C Generators Work).

EXCLAMATION POINT is a punctuation mark (!) that indicates some strong feeling in connection with what is being said. It serves as a signpost to a reader that a sentence expresses intense feeling. But it is a weak substitute for the techniques a good writer should use if he wishes to express strong emotions. An exclamation point may end a declaratory statement (He's a genius!), a question (Isn't that a shame!), or a fragment (After midnight!). It may express an exclamation (What a relief!), a wish (If only he'd come!), or a cry (Help!).

As these examples show, exclamation points are commonest in written dialogue. They should be used carefully in any writing, and very seldom in formal writing.
SUMNER IVES

EXCOMMUNICATION is a punishment by which a church bans a member from taking part in its rites and services. In its early form, it usually allowed the offender to join in some parts of public worship, on a level with unbaptized persons, but barred him from the sacraments. In some cases, the excommunication was for a certain period of time. Until this period was up, the banned one could not enter the church.

Anathema represents the gravest form of excommunication. Those under this ban are cast completely out from the shelter of the church. In the Middle Ages, this punishment would not only affect the offender's religious standing, but could upset completely his position in society. Punishment by excommunication was done away with in the Church of England and in the Presbyterian churches of Scotland by 1700. The Roman Catholic Church still uses it.
FULTON J. SHEEN

EXCRETORY SYSTEM. See ELIMINATION.

EXECUTION, in civil law, see DEBT. In criminal law, see CAPITAL PUNISHMENT.

EXECUTIVE, *ehg ZECK yoo tihv*, or *ehk SEHK yoo tihv*, is the branch of government that enforces the laws. The United States Constitution divides the work of government into three parts, *legislative*, *executive*, and *judicial*. Congress has the duty of legislation, or passing laws; the courts have the duty of judging; and the President is the Chief Executive, who carries out the laws. The individual states divide the work of government in a similar way, with the governor as executive. In a monarchy, the chief executive of the government is in theory the king or queen, although in practice a prime minister or premier generally does the work. See also CABINET; GOVERNOR GENERAL; PRESIDENT.
PAYSON S. WILD, JR.

EXECUTIVE DEPARTMENT. See UNITED STATES CONSTITUTION (Article II); UNITED STATES, GOVERNMENT OF.

EXECUTIVE MANSION. See WHITE HOUSE.

EXECUTOR, *ehg ZEHK yoo tur*, is a person named in a will to carry out its provisions. The executor acts as the representative of the person who made the will. His main duty is to handle and dispose of the money and other property left by the person who appointed him.

Any person who is 21, sound in mind, and of good reputation may be an executor. A person may refuse to act as executor. But once he takes the job, he can rid himself of it only with a court's permission.

A court supervises the executor's handling of an estate. The executor must offer the will for *probate*. This court process establishes the will as a legally effective paper. After paying all claims against the estate, the executor pays the legacies provided for in the will. He makes a record of the property of the estate and sells it if necessary to turn it into cash. Once a year, or oftener if the law requires it, the executor files an account of his handling of the estate with the probate court. His expenses are allowed by the court, and his services are paid for at rates set by law. The executor sometimes gives a bond, or money pledge, that he will perform his duties honestly. But often, the will states that no such bond is required.

If a person dies leaving no will, or if his will names no executor, the courts may appoint an administrator, who will then manage the estate for the heirs in place of an executor.
WILLIAM TUCKER DEAN

See also ADMINISTRATOR; ESTATE; PROBATE; WILL (document).

EXEGESIS, *ECK see JEE sis*, is an explanation or interpretation of any writing. The term usually applies to the Scriptures. The Talmudical writings give the Jewish exegesis of the Old Testament.

EXERCISE is any type of physical activity that uses the muscles of the body. Sports of all kinds, such as football, baseball, and swimming, provide healthful exercise. So do gardening, painting, and other odd jobs that have to be done around the home. All such activities may require running, jumping, throwing, squatting, lifting, pushing, or other movements that put the body's muscles to work.

Importance of Exercise. Exercise is important throughout life. The growing bodies of young boys and girls need exercise in order to develop properly. In the adult years, exercise helps keep the body in good physical condition. It aids health by improving such body functions as blood circulation, breathing, digestion, and metabolism—the processes by which the body transforms food into energy and tissue (see METABOLISM). By aiding physical health, exercise also improves mental health.

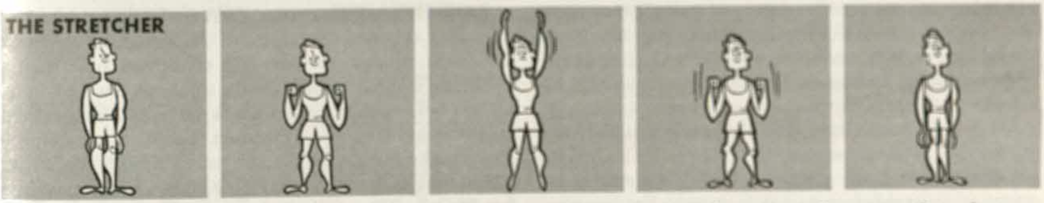
The effects of exercise are often noticeable. Persons who obtain the proper amounts and kinds of exercise usually develop firm muscles, and have good posture and skin color. Exercise also improves the sense of balance and the general strength, power, and endurance of the body.

Physical educators believe that exercise has become even more important today, because machines have taken over so many tasks once performed by hand. For example, vacuum cleaners and washing machines have greatly eased the work once required of housewives. Electric and gas ranges have ended the daily or weekly drudgery of chopping wood for the kitchen stove. In factories, electric saws, cranes, and other machines have reduced the amount of activity needed to perform many jobs. Automobiles, television, radio, movies, and similar nonactive recreations occupy much of the free time of Americans and make it hard to get enough exercise.

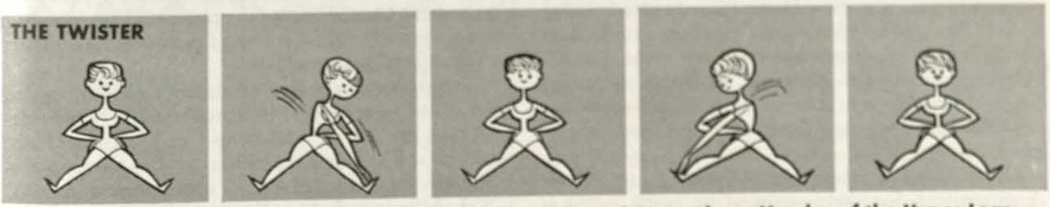
H. Armstrong Roberts

Exercise and Fun Go Hand-in-Hand for both young and old. Exercise builds muscles and helps keep the body healthy.

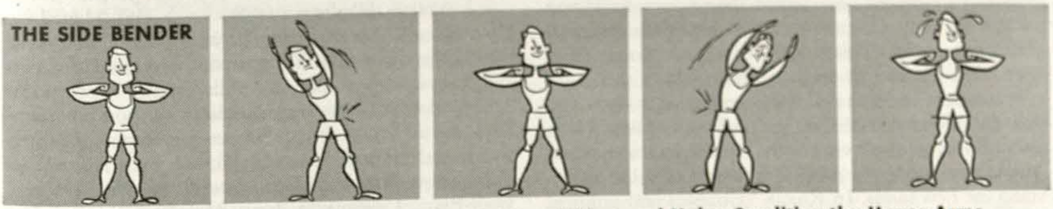
Kinds of Exercise. Sports furnish one of the most popular ways of obtaining exercise. Americans play some 60 sports, including baseball, basketball, football, golf, tennis, handball, bowling, and volleyball (see SPORTS AND SPORTSMANSHIP). Many of these sports, such as football and wrestling, demand a great deal of activity and are better suited for young persons. Others, such as hiking, dancing, cycling, golf, skating, and



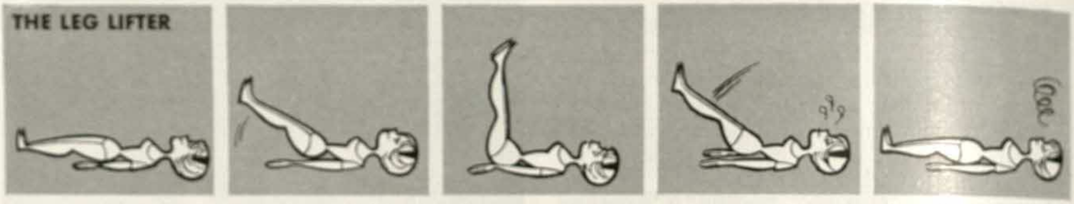
The Stretcher Exercises Many Muscles and Helps Limber Up the Body Before More Strenuous Exercises.



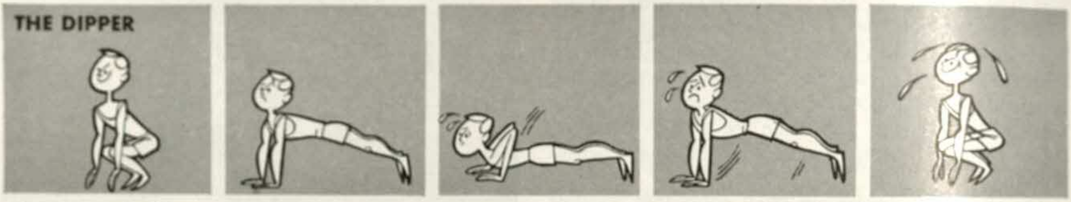
The Twister Helps Trim Inches Off the Waist and Also Pulls and Strengthens Muscles of the Upper Legs.



The Side Bender Stretches Side Muscles at the Waist and Hips, and Helps Condition the Upper Arms.



The Leg Lifter Strengthens Stomach Muscles Above and Below the Waist and Helps Reduce the Thighs.



The Dipper Builds Up Muscles in the Arms and Legs and Helps Limber Up and Condition the Entire Body.

calisthenics, provide less strenuous but equally healthful exercise for older persons. Many persons install jungle gyms, swimming pools, baskets for basketball, and similar apparatus in their backyards. All exercise provides the most benefits when combined with good diet, rest, and the proper medical attention. The fun and fellowship provided by sports are also important.

In addition to sports, work activities around the house can provide exercise. Washing floors, painting walls, and weeding in the garden are among the home activities that provide helpful exercise. Exercise can also be important to correct some kinds of physical ailments. Doctors often require people who are overweight to perform certain kinds of calisthenics regularly. Persons who suffer broken arms or legs may need special arm or leg exercises to restore these parts of the body to full use. Swimming has sometimes proved helpful to polio victims. T. K. CURETON, JR.

See also CALISTHENICS; GYMNASTICS; PHYSICAL EDUCATION; PHYSICAL FITNESS.

EXETER, N.H. (pop. 5,896; alt. 60 ft.), is a residential center 15 miles southwest of Portsmouth. For location, see NEW HAMPSHIRE (color map). Exeter is one of the oldest settlements in New Hampshire. It was founded by the Rev. John Wheelwright in 1638. It served as the capital of New Hampshire for much of the time between 1774 and 1808. Exeter is the home of Phillips Exeter Academy. J. DUANE SQUIRES

EXHIBITION. See ART MUSEUM; FAIRS AND EXPOSITIONS; MUSEUM.

EXILE, *EHK sile,* is banishment from one's own land. A person who has been punished by being exiled is called an *exile.* Many countries adopting a different form of government have exiled their rulers. Exile was a common form of punishment for crimes and political offenses in ancient Palestine, Greece, and Rome. Civil wars often resulted in exile for those who lost.

In modern times many countries sent criminals and political offenders to distant parts of their realms. Thus, Great Britain sent convicts to the American colonies and Australia, in order to provide a source of labor to develop the new lands. In Russia, criminals and political offenders are still sent in great numbers to work in Siberia. Most exiles of the present day are people who fled from their own countries because they were threatened by the tyrannical governments there. The growth of fascist and communist forms of government after World War I made this type of exile common. Many political leaders have been exiled because of changes in some Latin-American governments.

The homesickness of the exile is a favorite theme of literature. In the Bible, Cain, sent to wander over the face of the earth, cries out that his punishment is more than he can bear. Many poets have spent part of their lives in exile, and have expressed their longing for their home. HUNTINGTON CAIRNS. Critically reviewed by TELFORD TAYLOR

EXISTENTIALISM, *EGG sis TEN shul ism,* is a philosophy that originated in Europe. Its name comes from the word *existence,* because it is concerned with man's existence and his situation in the universe. Most existentialists believe that man is a unique being. He belongs in the world with natural things. But he alone can reflect, make free decisions, and set goals. Existentialists claim that man must find out for himself what meaning his life has. They believe that in order for him to exist in the fullest sense, he must engage in a life of reflection, and commit himself to his own projects. They say that each man must learn to act as a free person rather than as a mere part of a crowd.

Existentialists recognize a human tendency to rise above nature and society in search of God. Some existentialists are *atheists* who deny God's existence. But most claim that man's aspirations lead to God as a living reality, and as a social bond among human beings.

The philosophy developed from the teachings of Søren Kierkegaard. It was influenced by Karl Jaspers (1883-), Martin Heidegger (1889-), and Miguel de Unamuno. It became popular in France after World War II, partly because it was usually expressed in novels and plays, rather than in philosophical discussions. Among the best-known existentialist authors are Jean-Paul Sartre (1905-), Simone de Beauvoir (1907-), and Gabriel Marcel (1887-). JAMES COLLINS

See also KIERKEGAARD, SØREN AABYE; SARTRE, JEAN-PAUL; UNAMUNO Y JUGO, MIGUEL DE.

EXOCRINE. See GLAND.

EXODUS is the second book of the Bible. It follows Genesis, and takes up the story of the Israelites in Egypt after the death of Joseph. The first part of the book tells of the life of the Israelites as slaves in Egypt, the attempts of their leader Moses to free them, and the Ten Plagues that God brought on the Egyptians. It then describes the *exodus*, or going forth, to freedom and the miraculous escape from the pursuing Egyptians at the Red Sea.

Chapter 20 contains the *Decalogue*, or Ten Commandments, that God revealed to Moses at Mount Sinai amid earthquake and fire. The next three chapters, often called "Book of the Covenant," give more detailed laws dealing with all phases of ancient Israelite life. Scholars have studied the similarities and differences between these laws and other ancient Semitic codes, such as the Assyrian laws and the Babylonian Code of Hammurabi (see HAMMURABI). The last section of Exodus (chapters 25 to 40) describes the *Tabernacle*, or movable tent, that Moses and the people built for public worship in the desert. Chapter 32 tells the story of the Golden Calf that the Israelites worshiped while Moses was on Mount Sinai. ROBERT GORDIS

Related Articles in WORLD BOOK include:

Golden Calf
Moses
Passover
Pentateuch
Tabernacle
Ten Commandments

EXOGAMY. See MARRIAGE (Marriage Customs).

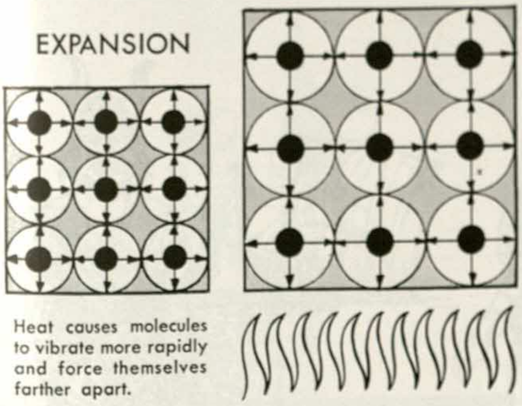
EXORCISM, *ECK saur siz'm,* is a form of magic. Exorcists believe that they have the power to cast out evil spirits. They perform certain ceremonies and say "magic" words (often holy names) to try to make devils and other spirits obey their commands.

EXOSKELETON. See ARTHROPOD.

EXOSPHERE. See AIR (The Four Layers).

EXOTIC PLANT. See BOTANY (Terms).

EXPANDING UNIVERSE. See ASTRONOMY (The Expanding Universe).



EXPANSION

Heat causes molecules to vibrate more rapidly and force themselves farther apart.

EXPANSION, *ehks PAN shun,* in physics, is the increase in the size of a body without the addition of more material. Nearly all solids expand when heated and contract when cooled.

The amount of expansion varies with the nature of the substance. Aluminum expands twice as much as iron at the same temperature, and brass expands one and one-half times as much as iron. Heat expands bodies because it makes their molecules vibrate more rapidly, and in doing so these molecules are pushed farther apart. Thermostats operate on this principle. They control the amount of heat in a room by the fact that they contain certain metals that always expand or contract at the same rate when heated or cooled.

Bread dough rises in an oven because the heat expands the carbon dioxide in the mass. The same principle applies in cooking an omelet. RALPH G. OWENS

See also GAS; HEAT; HYDROSTATICS.

EXPATRIATION. See CITIZENSHIP (Expatriation); NATURALIZATION (Denaturalization).

EXPECTATION OF LIFE. See LIFE (Length of Life).

EXPERIMENT STATION. See AGRICULTURAL EXPERIMENT STATION.

EXPERIMENTATION, SCIENTIFIC, is a method used to discover facts and to test ideas. Actually, the scientist uses many different techniques and methods, depending upon what he is trying to prove by the experiment. Scientific experimentation is one important way of discovering facts. A scientist has an idea about solving a problem. He then plans an experiment to test his idea. He usually knows what he would like to find, and he tries to predict the outcome of the experiment. For example, he may want to cure rabbits of a disease called *rickets*. He has observed that not all rabbits have the disease. He wonders whether the healthy rabbits eat different food, stay in cooler places, receive more sunshine, drink more water, or have stronger parents than the diseased rabbits. From these and other possible causes, he may believe that some types of food will cure the disease.

He next plans an experiment to test his idea. He divides a number of diseased rabbits into two groups: an *experimental group* and a *control group*. Because he is trying to discover the effect of food on the rabbits, he treats both groups exactly alike, except for the food he hopes will cure the rabbits in the experimental group. The animals receive the same amount of exercise, sunshine, and water. The scientist then predicts that there will be a difference in the improvement of the two groups. If the difference turns out to be significant, the scientist has discovered something true about the relationship of food and rickets in rabbits. He keeps a precise and accurate record of his experiments. If the rabbits in the experimental group gain weight, become more lively, and have straighter bones than the rabbits in the control group, the scientist *might* have made an important discovery. The information may be valuable for curing rickets in other animals and human beings.

Any worthwhile scientific experiment must be capable of being repeated, not only by the original experimenter, but by other scientists. If continued experiments establish the same facts, the scientist has reason to believe that his experiments have value, and he reports his findings to other scientists so that they can try his experiment. If they verify the findings, the original experimenter is credited with having made an important discovery. The facts are recorded for future use.

Not all experiments deal with animals. Some experiments are performed with electricity, chemicals, machines, or people. H. CRAIG SIPE

See also INSTRUMENT, SCIENTIFIC; SCIENCE (How Scientists Work).

EXPIRATION. See DIAPHRAGM.

EXPLORATION AND DISCOVERY are as old as man. The Stone Age men who hunted the forests in prehistoric times were explorers. They were no doubt as daring and resourceful as such later explorers as Marco Polo, Christopher Columbus, and Captain James Cook. We do not know the names of the prehistoric explorers. But neither do we know who invented the first wheel. We only know that the wheel was invented. And we also know that man has always responded to the urge to explore and discover.

At first, men searched for the *means* to live. Later they searched for the things that made life *worth* living. A cave man looked for a jagged stone to use as a tool. Christopher Columbus sailed across the Atlantic Ocean to the Western Hemisphere. And today pilots train to fly into outer space. The same human force has driven them all—man's will *to live* and his desire *to have* and *to know*. This urge has taken men from ocean to ocean and continent to continent, from the Stone Age to the Space Age. It is the greatest of all adventure stories. But it is a story whose beginning is unknown and whose end is not in sight.

Early Explorers

Egyptians. The first explorer known to history was an Egyptian named Hannu. He lived more than 4,000 years ago. At that time the Egyptians believed that the world was a flat disc surrounded by water. They called this body of water the Heavenly River. They thought the Nile flowed out of it through a mountain cavern in the south. The Egyptians were fine craftsmen and great architects and engineers. But they had little liking for the sea. However, a group of Egyptians did make a remarkable sea voyage under Hannu in 2750 B.C. to the Land of Punt, somewhere on the Red Sea coast of Somaliland. The Land of Punt was rich in gold, ivory, incense trees, and the myrrh the Egyptians used to embalm their dead.

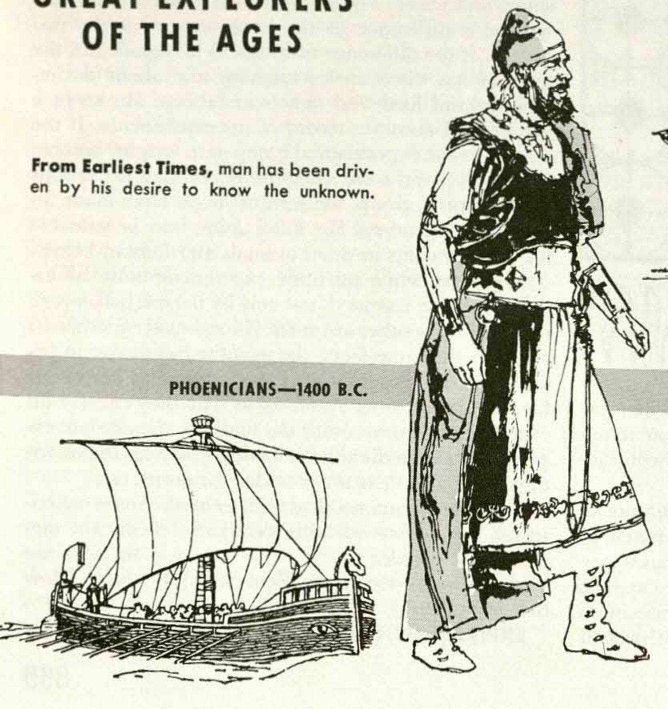
Hannu led his expedition across the desert to the northern end of the Red Sea. Here the Egyptians built ships and set sail for Punt. The people of Punt were friendly. Hannu loaded his ships with treasure and made his way safely back to Egypt. On his return he had the story of his remarkable voyage carved on a stone. This stone still exists, and that is how we know about Hannu and the Land of Punt.

Hannu's ship had a flat bottom and a protruding bow and stern. It was made of many small pieces of wood fitted together and reinforced with rope and rawhide. It had a single mast, shaped like an inverted V, and a single sail. It was steered by means of crude paddle rudders fastened to the sides. When the wind was unfavorable for sailing, standing oarsmen rowed the vessel. The Egyptian ships were suited to the Nile River and the Red Sea. And the Egyptians, not being a seafaring people, had little interest in exploring the Mediterranean.

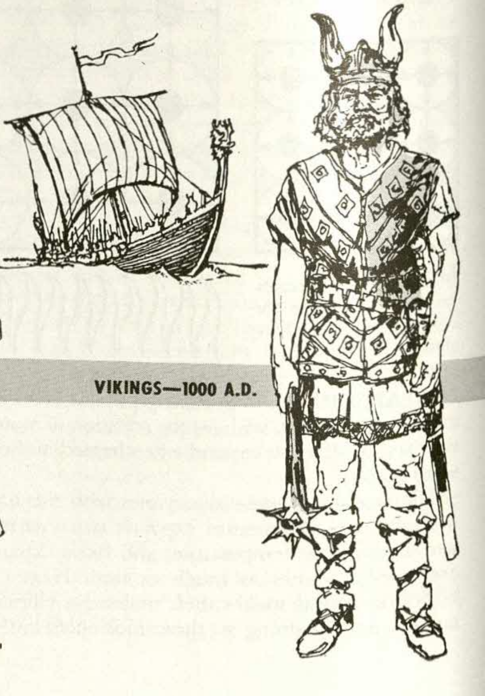
Minoans who lived on the island of Crete were the next explorers known to history. From about 3000 to 1400 B.C., Crete was the center of a great civilization. The Minoans were the exact opposite of the land-loving Egyptians. Like most island people, they were sailors. Their wealth came from sea trade. During the centuries of Crete's power, its sailors explored the whole Mediterranean world. The Minoans used small tublike boats with a single sail. Like the Egyptians, they could use the sail only when the wind blew from behind, for they still knew nothing about the art of *tacking* (see SAILING). The Minoans accomplished remarkable feats in these tiny vessels that were little bigger than a rowboat. They had no navigational instruments. They did not even have anchors. They had no means of

GREAT EXPLORERS OF THE AGES

From Earliest Times, man has been driven by his desire to know the unknown.



PHOENICIANS—1400 B.C.



VIKINGS—1000 A.D.

cooking aboard, and no room to lie down. They had to beach their craft to eat and sleep and gather provisions. Fortunately, the Mediterranean has few tides. Except at certain seasons the winds are mild. There are also many islands to land on. All these factors enabled the Minoan sailors to explore the Mediterranean Sea.

Phoenicians. About 1400 B.C., barbarian invaders conquered Crete, and the rich trade of the Mediterranean world fell into the hands of the Phoenicians. Phoenicia, which means "Land of Palms," lay along the coast of modern Israel and Syria (see PHOENICIA). The Bible refers to the Phoenicians as "merchants of the peoples" and says that their ships brought them "into great waters."

By 800 B.C., Phoenician boats were no longer tublike, but long and narrow with proper keels. The boats also had anchors made of skin sacks filled with stones. The development of the keel and discovery of the anchor marked a great advance in navigation. The Phoenicians learned to cover decks and to construct ships large enough for a double row of oarsmen. These ships were known as *biremes*. Ships with three banks of oars were called *triremes*. By 600 B.C., the biremes and triremes of Phoenicia had ventured past the Strait of Gibraltar into the Atlantic Ocean. They had edged their way up the west coast of Europe, crossed to the Scilly Islands, and even landed in England. Their caravans had plodded over the trackless deserts of Arabia and through the wild mountain passes of Parthia and northern India. They may even have sailed around Africa!

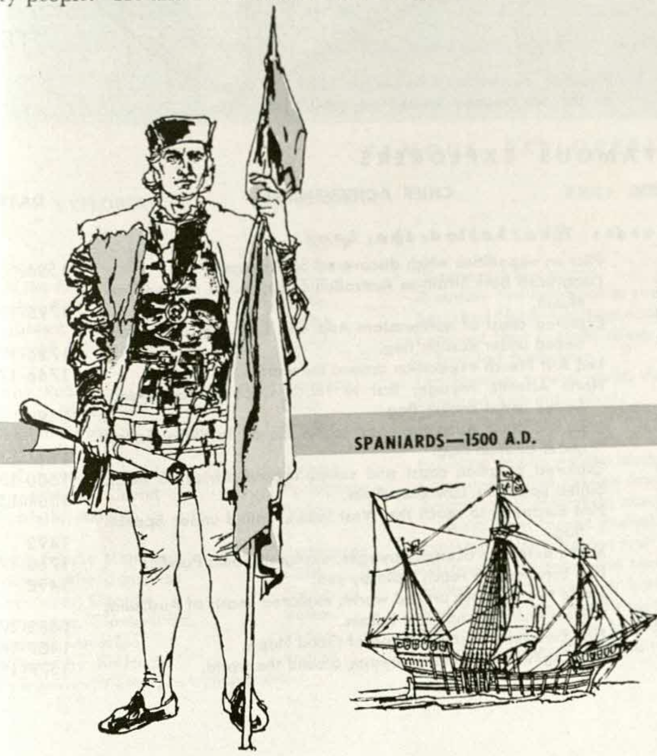
Carthaginians were the next great explorers. Carthage lay on the site of modern Tunis in northern Africa. The Carthaginians explored Africa as far south as Cape Verde. Here, about 500 B.C., an expedition under a famous sea captain, Hanno, discovered an island inhabited by what he described as "little dark hairy people." He and his men succeeded in capturing some of the "women," but the "men" escaped. These "people" were, of course, not people at all, but apes.

Greeks were at the height of their power during the 400's and 300's B.C. In its day, Greece had the greatest civilization the world has known until our own.

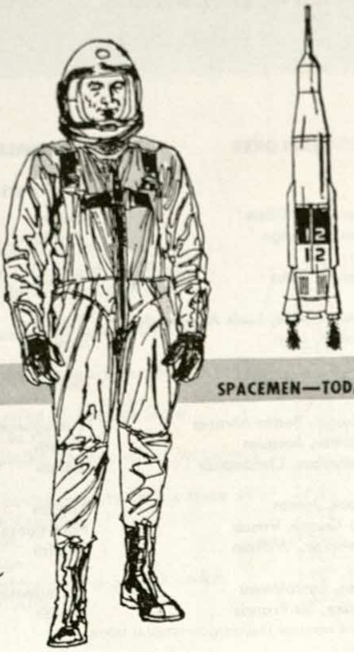
Alexander. The most outstanding explorer of Greece was Alexander the Great, King of Greece and Macedonia. In the days of Alexander, some philosophers believed the earth to be round, but none knew its size. Alexander had no idea how far it was to the ends of the earth, but he intended to go there.

In 334 B.C., Alexander crossed the Hellespont (Dardanelles) from Europe to Asia and camped his army on the plains of Troy. From Troy, Alexander marched inland to the ancient country of Phrygia between the Mediterranean and Black seas. In Phrygia there was a chariot that had once belonged to a Phrygian king. The chariot stood in a temple. Legend tells us that the yoke of this chariot was bound to the pole with knotted bark. This curious knot was known as the Gordian knot. An oracle said that whoever succeeded in undoing the Gordian knot would rule all Asia. When Alexander reached the temple, the priests told him that many men had tried to undo the knot but all had failed. With a quick movement, Alexander drew his sword and slashed the knot in two. He believed that if you could not do a thing one way, you did it another. He had no patience with those who said, "It cannot be done." During the next four years Alexander defeated the Persians, overran Phoenicia, and made himself master of Egypt.

In 330 B.C., Alexander left Egypt and marched again to Asia. He fought his way across the deserts of Arabia, through the passes of the Hindu Kush mountains, then south to the mountains of Afghanistan. Once over these

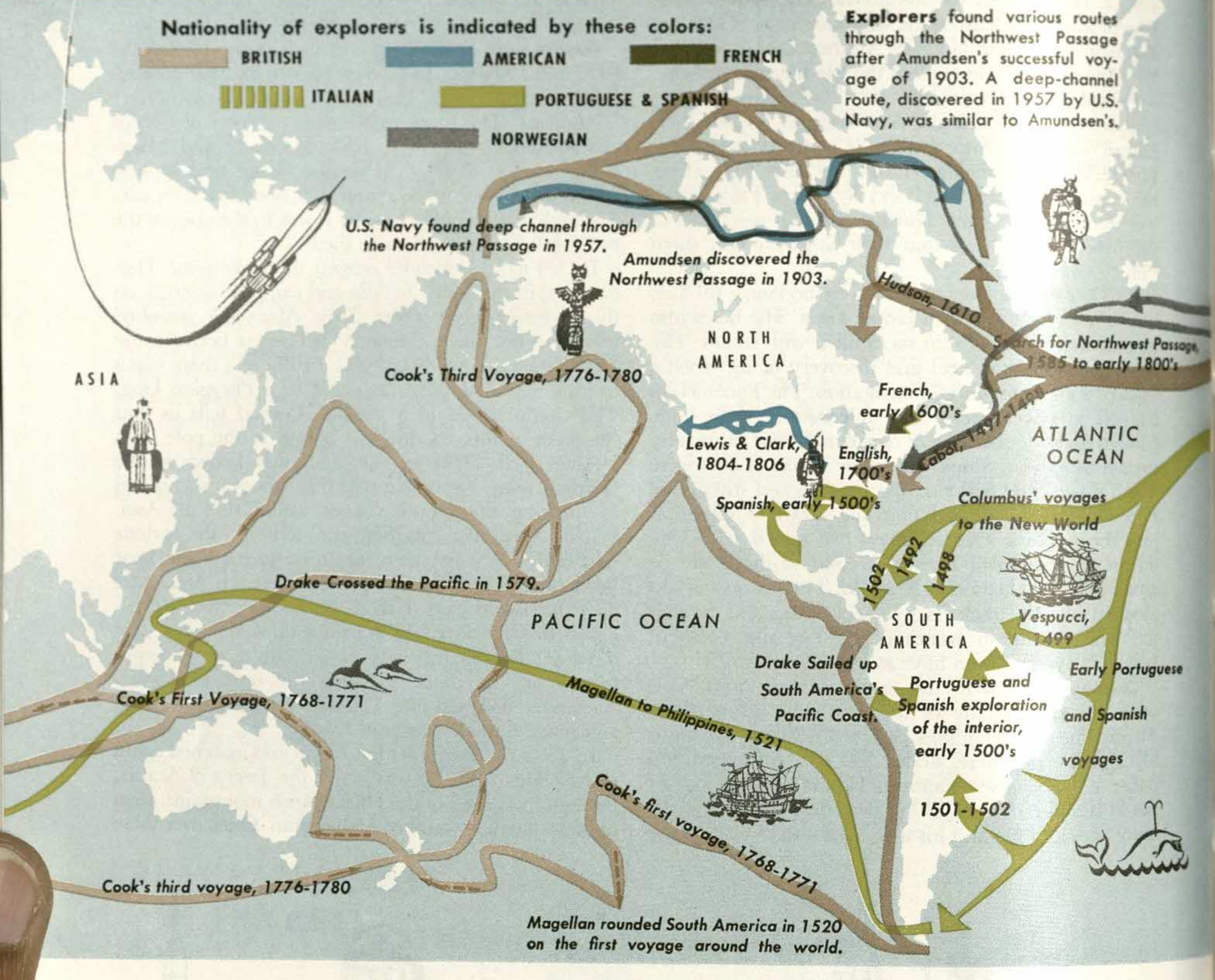


SPANIARDS—1500 A.D.



SPACEMEN—TODAY

LEADING VOYAGES AND EXPEDITIONS OF DISCOVERY



Nationality of explorers is indicated by these colors:

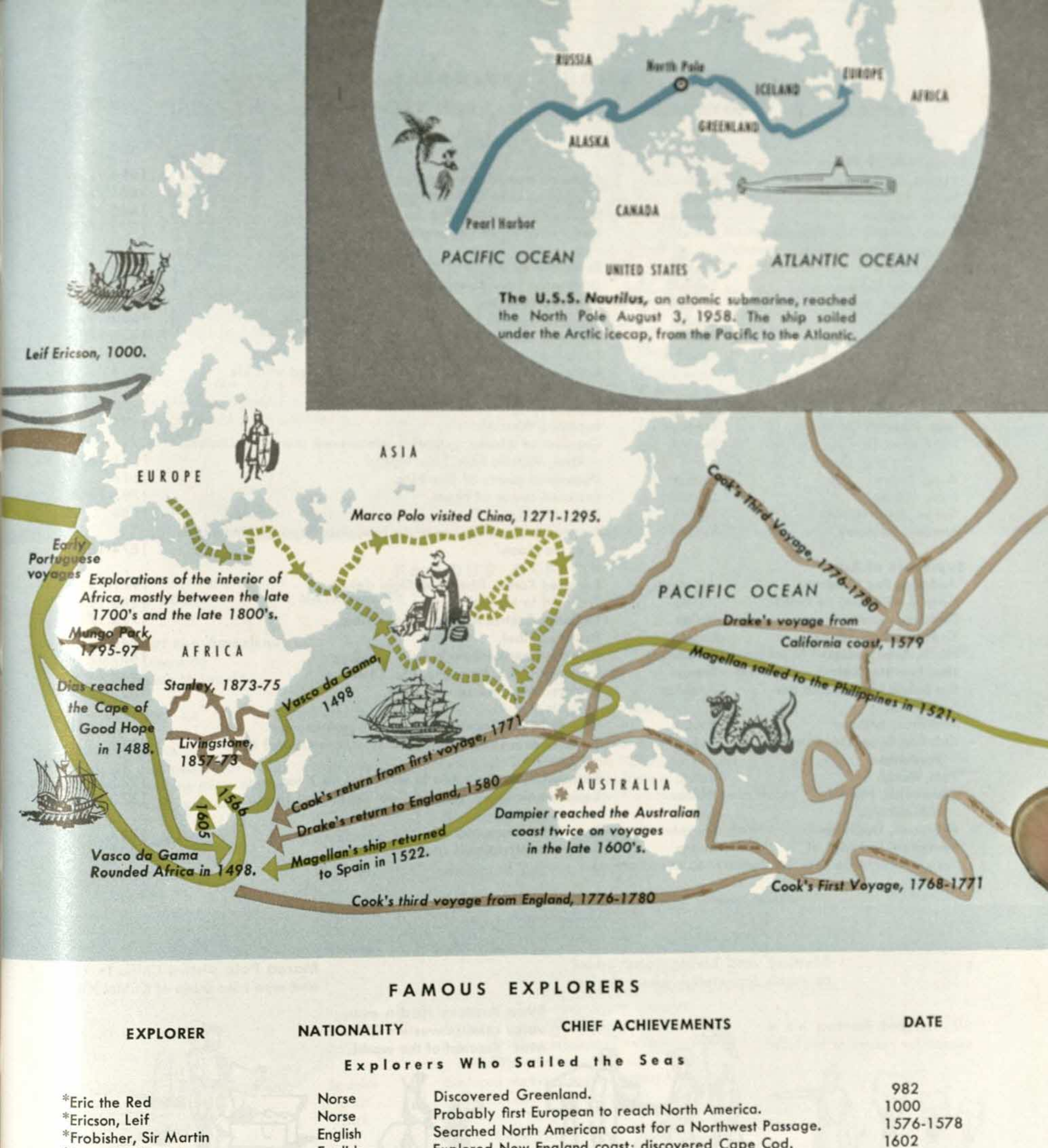
BRITISH
AMERICAN
FRENCH
ITALIAN
PORTUGUESE & SPANISH
NORWEGIAN
ASIA
U.S. Navy found deep channel through the Northwest Passage in 1957.
Amundsen discovered the Northwest Passage in 1903.
NORTH AMERICA
Hudson, 1610
Search for Northwest Passage, 1585 to early 1800's
Cook's Third Voyage, 1776-1780
French, early 1600's
Cabot, 1497-1498
ATLANTIC OCEAN
Lewis & Clark, 1804-1806
English, 1700's
Spanish, early 1500's
Columbus' voyages to the New World
1502
1492
1498
Drake Crossed the Pacific in 1579.
PACIFIC OCEAN
SOUTH AMERICA
Vespucci, 1499
Drake Sailed up South America's Pacific Coast.
Portuguese and Spanish exploration of the interior, early 1500's
Early Portuguese and Spanish voyages
Cook's First Voyage, 1768-1771
Magellan to Philippines, 1521
Cook's first voyage, 1768-1771
1501-1502
Cook's third voyage, 1776-1780
Magellan rounded South America in 1520 on the first voyage around the world.

Explorers found various routes through the Northwest Passage after Amundsen's successful voyage of 1903. A deep-channel route, discovered in 1957 by U.S. Navy, was similar to Amundsen's.

FAMOUS EXPLORERS

EXPLORER	NATIONALITY	CHIEF ACHIEVEMENTS	DATE
		Explorers Who Sailed the Seas	
*Barents, Willem	Dutch	Pilot on expedition which discovered Spitzbergen.	1596
Bass, George	English	Discovered Bass Strait on Australian coast; sailed around Tasmania.	1795-1798
*Bering, Vitus	Danish	Explored coast of northeastern Asia and Bering Strait region. Sailed under Russian flag.	1725-1741
Bougainville, Louis Antoine de	French	Led first French expedition around the world.	1766-1769
*Cabot, John	Italian	North Atlantic voyage; first to reach Cape Breton Island. Sailed under English flag.	1497
*Cabot, Sebastian	Italian	Explored South American coast to the Rio de la Plata. Sailed under Spanish flag.	1526-1530
*Cabral, Pedro Álvares	Portuguese	Explored Brazilian coast and sailed around Africa to India.	1500-1501
*Cartier, Jacques	French	Sailed up the St. Lawrence River.	1534-1536
*Columbus, Christopher	Italian	First European to reach the West Indies. Sailed under Spanish flag.	1492
*Cook, James	English	Made extensive oceanic voyages; explored South Pacific.	1768-1779
*Da Gama, Vasco	Portuguese	First European to reach India by sea.	1498
Dampier, William	English	Made two voyages around world; explored coasts of Australia, New Guinea, and New Britain.	1683-1707
*Dias, Bartolomeu	Portuguese	First European to round Cape of Good Hope.	1487-1488
*Drake, Sir Francis	English	First Englishman to make voyage around the world.	1577-1580

*Has a separate biography in WORLD BOOK.


RUSSIA
North Pole
ICELAND
EUROPE
AFRICA
GREENLAND
ALASKA
CANADA
Pearl Harbor
PACIFIC OCEAN
UNITED STATES
ATLANTIC OCEAN
Leif Ericson, 1000.
EUROPE
ASIA
Marco Polo visited China, 1271-1295.
Early Portuguese voyages
Explorations of the interior of Africa, mostly between the late 1700's and the late 1800's.
Mungo Park, 1795-97
AFRICA
Dias reached the Cape of Good Hope in 1488.
Stanley, 1873-75
Livingstone, 1857-73
Vasco da Gama, 1498
1566
1605
Vasco da Gama Rounded Africa in 1498.
Cook's return from first voyage, 1771
Drake's return to England, 1580
Magellan's ship returned to Spain in 1522.
Cook's third voyage from England, 1776-1780
Cook's Third Voyage, 1776-1780
PACIFIC OCEAN
Drake's voyage from California coast, 1579
Magellan sailed to the Philippines in 1521.
AUSTRALIA
Dampier reached the Australian coast twice on voyages in the late 1600's.
Cook's First Voyage, 1768-1771

The U.S.S. *Nautilus*, an atomic submarine, reached the North Pole August 3, 1958. The ship sailed under the Arctic icecap, from the Pacific to the Atlantic.

FAMOUS EXPLORERS

EXPLORER	NATIONALITY	CHIEF ACHIEVEMENTS	DATE
		Explorers Who Sailed the Seas	
*Eric the Red	Norse	Discovered Greenland.	982
*Ericson, Leif	Norse	Probably first European to reach North America.	1000
*Frobisher, Sir Martin	English	Searched North American coast for a Northwest Passage.	1576-1578
*Gosnold, Bartholomew	English	Explored New England coast; discovered Cape Cod. Founded Jamestown.	1602 1606
*Gray, Robert	American	Led voyages around world; discovered Columbia River.	1787-1793
Hartog, Dirck	Dutch	Explored Australian coast.	1616
*Hudson, Henry	English	Discovered Hudson Bay; explored Hudson River. Sailed under Dutch flag.	1609-1610
La Pérouse, Comte de	French	Explored Asiatic waters; discovered La Pérouse Strait.	1785-1788
*Magellan, Ferdinand	Portuguese	Commanded first voyage around the world.	1519-1522
Pigafetta, Antonio	Italian	Accompanied Magellan; completed voyage after Magellan's death. Kept famous journal.	1519-1522
Pinto, Fernão Mendez	Portuguese	Explored Asiatic waters; first European to touch Japanese soil.	1546
*Tasman, Abel Janszoon	Dutch	Discovered Tasmania and New Zealand.	1642
*Vancouver, George	English	Sailed around Vancouver Island.	1792
*Verrazano, Giovanni da	Italian	Searched for Northwest Passage.	1524
*Vespucci, Amerigo	Italian	Made several voyages to West Indies and South America.	1497-1503
Willoughby, Sir Hugh	English	Sought a northeast passage to Asia.	1553

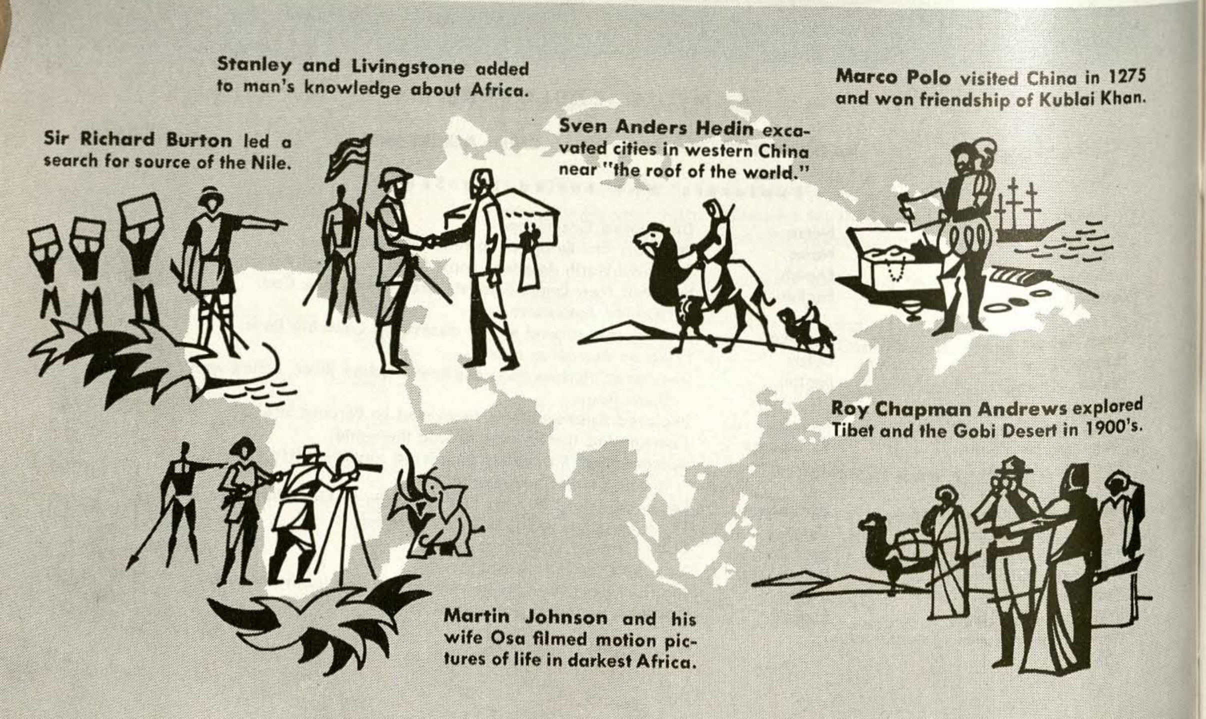
*Has a separate biography in WORLD BOOK.

FAMOUS EXPLORERS

Inland Explorers

EXPLORER	NATIONALITY	CHIEF ACHIEVEMENTS	DATE
Explorers of Africa			
*Akeley, Carl Ethan	American	Explored many parts of Africa.	1896-1926
Baker, Sir Samuel White	English	Discovered Lake Albert.	1864
Barth, Heinrich	German	Explored the Sahara and the Sudan.	1845-1855
Brazza, Pierre Paul François Camille Savorgnande	French	Explored southern and western Africa.	1875-1883
Bruce, James	Scottish	Rediscovered source of Blue Nile.	1770
*Burton, Sir Richard	English	Discovered Lake Tanganyika.	1858
Clapperton, Hugh	Scottish	Explored Nigeria.	1822-1827
Denham, Dixon	English	Explored Central Sudan and Lake Tchad region.	1822-1827
Du Chaillu, Paul	French	Explored Central Africa.	1856-1859
*Emin Pasha (Schnitzer, Eduard)	German	Explored Central Africa.	1878-1890
*Johnson, Martin Elmer and Osa Helen Leighty	American	Explored many parts of Africa; photographed wild life.	1924
Laing, Alexander	Scottish	Explored Niger Basin.	1824
Lenz, Heinrich Oskar	German	Explored West Africa.	1874-1880
*Livingstone, David	Scottish	Greatest of African explorers; discovered source of Zambezi River, Victoria Falls, Lake Ngami.	1841-1871
Páez, Pedro	Spanish	Discovered source of Blue Nile.	1618
Park, Mungo	Scottish	Explored course of Niger.	1795-1805
Speke, John Hanning	English	Discovered Lakes Tanganyika and Victoria.	1858
*Stanley, Sir Henry	Welsh	Proved the correct source of the Nile, discovered the "Mountains of the Moon."	1874-1889
Explorers of Asia			
*Andrews, Roy Chapman	American	Explored Korea, Tibet, and Gobi desert.	1911-1930
Carpini, Giovanni de Piano	Italian	Traveled to Mongolia.	1246-1248
Desideri, Ippolito	Italian	Explored Central Asia, especially Tibet.	1714-1716
Gregory, John Walter	English	Explored Tibet.	1922
*Hedin, Sven Anders	Swedish	Numerous explorations in Asia.	1885-1933
Huc, Evariste Regis	French	Explored China, Mongolia, and Tibet.	1839-1844
Ibn-Batuta (Muhammad ibn Abdulla)	Arabian	Explored Middle East and India.	1325-1353
Jenkinson, Anthony	English	Explored from Caspian region north to Archangel.	1557-1581
Oderico, Friar (Odoric of Pordenone)	Italian	Traveled in southern Asiatic waters and in Central Asia.	1318
*Polo, Marco	Italian	Traveled throughout Asia in service of the Khan.	1275-1292
Przhevalski, Nikolai Mikhailovich	Russian	Explored Mongolia, crossed Gobi desert and Tibet.	1870-1873
Rubruquis, Guillaume	Flemish	Traveled to Mongolia.	1253
Varthema, Lodovico di	Italian	Coastal exploration in southern Asia.	1502-1507

*Has a separate biography in THE WORLD BOOK ENCYCLOPEDIA.



Stanley and Livingstone added to man's knowledge about Africa.

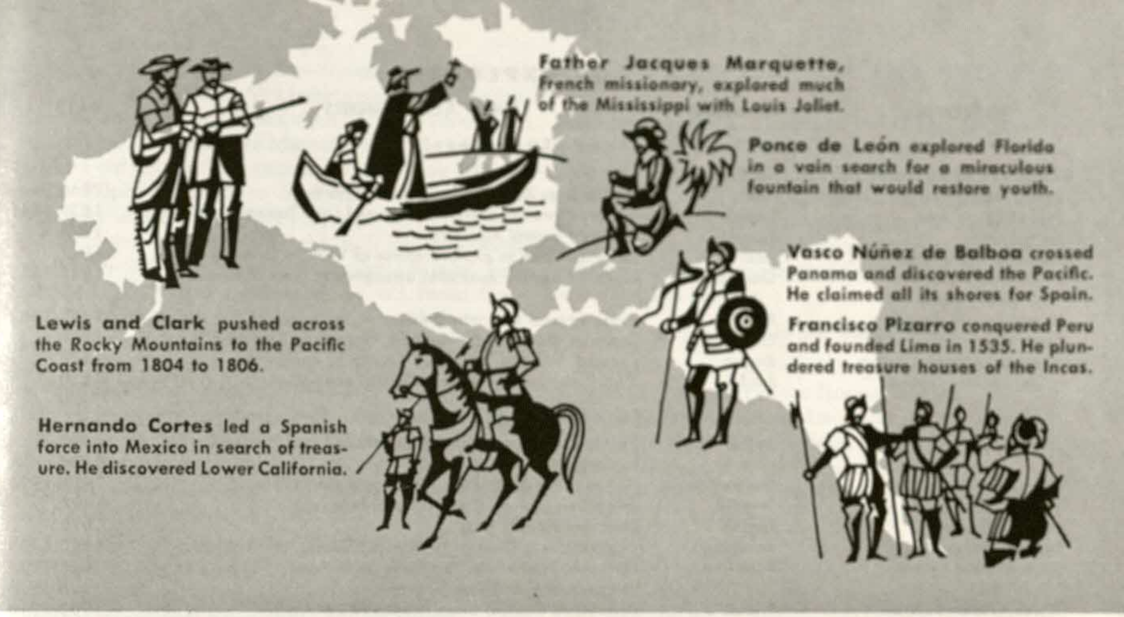
Sir Richard Burton led a search for source of the Nile.

Sven Anders Hedin excavated cities in western China near "the roof of the world."

Marco Polo visited China in 1275 and won friendship of Kublai Khan.

Roy Chapman Andrews explored Tibet and the Gobi Desert in 1900's.

Martin Johnson and his wife Osa filmed motion pictures of life in darkest Africa.



Father Jacques Marquette, French missionary, explored much of the Mississippi with Louis Joliet.

Ponce de León explored Florida in a vain search for a miraculous fountain that would restore youth.

Vasco Núñez de Balboa crossed Panama and discovered the Pacific. He claimed all its shores for Spain.

Francisco Pizarro conquered Peru and founded Lima in 1535. He plundered treasure houses of the Incas.

Lewis and Clark pushed across the Rocky Mountains to the Pacific Coast from 1804 to 1806.

Hernando Cortes led a Spanish force into Mexico in search of treasure. He discovered Lower California.

FAMOUS EXPLORERS

EXPLORER	NATIONALITY	CHIEF ACHIEVEMENTS	DATE
		Inland Explorers	
Explorers of the Americas			
Almagro, Diego de	Spanish	Crossed Atacama Desert in Chile; aided in conquest of Peru.	1525-1530
*Balboa, Vasco Núñez de	Spanish	Led expedition across Isthmus of Panama; discovered Pacific Ocean.	1513
*Bienville, Sieur de	French	Explored lower Mississippi Valley. Founded New Orleans.	1698-1720 1718
*Bridger, James	American	First white man to visit Great Salt Lake.	1824
*Cabeza de Vaca, Álvar Núñez	Spanish	Explored Gulf Plains from Florida to Mexico.	1527-1536
*Cadillac, Antoine de la Mothe	French	Explored upper Mississippi Valley.	1701
*Champlain, Samuel de	French	Explored St. Lawrence River westward to Lake Huron. Discovered Lake Champlain.	1603-1615 1609
*Clark, William	American	Led expedition across Rocky Mountains to Pacific Ocean (with Lewis).	1804-1806
Córdoba, Francisco Fernández de	Spanish	Discovered Yucatán.	1517
*Coronado, Francisco V. de	Spanish	Explored Arkansas plains and Grand Canyon region.	1540-1542
*Cortes, Hernando	Spanish	Conquered Mexico.	1519-1521
*De Soto, Hernando	Spanish	Discovered Mississippi River; explored southeastern United States.	1539-1542
*Duluth, Sieur	French	Explored Montreal and Lake Superior region.	1675-1687
*Frémont, John Charles	American	Carried on extensive western exploration in North America.	1838-1845
Hearne, Samuel	English	Explored northwestern North America.	1769-1772
*Hennepin, Louis	French	Explored upper Mississippi region.	1679-1680
*Iberville, Sieur d'	French	Explored lower Mississippi Valley; was first to enter Mississippi River from the sea.	1698-1701
*Jiménez de Quesada, Gonzalo	Spanish	Explored northern Andes region; founded Bogotá.	1536-1538
*Joliet, Louis	French	Explored Lake Superior region.	1672-1673
*La Salle, Sieur de	French	Discovered Niagara Falls; explored Lake Michigan region and Mississippi River.	1669-1680
*Lewis, Meriwether	American	Led expedition across Rocky Mountains to Pacific Coast (with Clark).	1804-1806
*Mackenzie, Sir Alexander	Scottish	Explored northwest Canada; discovered Mackenzie River.	1789
*Marquette, Jacques	French	Explored northern Mississippi Basin.	1668-1671
Narváez, Pánfilo de	Spanish	Explored mainland westward from Florida.	1527
*Oñate, Juan de	Spanish	Explored New Mexico.	1598
*Orellana, Francisco de	Spanish	Explored and named Amazon River.	1541
*Pike, Zebulon M.	American	Explored Middle West and Rocky Mountain region.	1805-1807
*Pizarro, Francisco	Spanish	Explored Peru; founded Lima.	1530-1538
*Ponce de León, Juan	Spanish	Discovered and explored Florida.	1513
*Radisson, Pierre Esprit	French	Explored Lake Superior and northern Mississippi region.	1659
*Smith, Jedediah Strong	American	Led party of seventeen men from Missouri to Rocky Mountains. First explorer of Great Basin.	1826
*Thompson, David	English	Explored western Canada.	1789-1814
*Tonti, or Tonty, Henri de	Italian	Explored Mississippi Valley.	1678-1683
Valdivia, Pedro de	Spanish	Conquered and explored Chile. Founded Santiago.	1540-1541

*Has a separate biography in THE WORLD BOOK.

FAMOUS EXPLORERS

EXPLORERS	NATIONALITY	CHIEF ACHIEVEMENTS	DATE
Inland Explorers			
Explorers of Australia			
Burke, Robert O'Hara	Irish	First to cross Australia from south to north.	1860
Eyre, Edward John	English	Explored interior deserts; discovered Lake Torrens.	1839-1841
Forrest, John	Australian	Explored central Australia.	1874
Kennedy, Edmund B.	Australian	Led expedition to explore course of Victoria River.	1847
Leichhardt, Friedrich Wilhelm Ludwig	German	Explored eastern Australia; attempted to cross continent.	1844-1845
Stuart, John McDouall	Scottish	Made several trips into interior.	1858-1862
Sturt, Charles	English	Explored southeastern Australia; discovered Darling River.	1828
Warburton, Peter Egerton	English	Crossed Australia from Alice Springs to Roeburne.	1873
Wills, William Gorman	English	With Burke on first transcontinental expedition.	1860
Polar Explorers			
Abruzzi, Duke of the	Italian	First to climb Mount Saint Elias (Alaska).	1897
		Explored Arctic regions.	1900
*Amundsen, Roald	Norwegian	First to reach South Pole. Flew across North Pole.	1911;1926
*Andrée, Salomon August	Swedish	Attempted balloon flight to North Pole region.	1897
*Baffin, William	English	Discovered Baffin Bay.	1616
*Bartlett, Robert Abram	American	Explorations in Greenland, Alaska, Siberia, and Labrador.	1897-1935
*Byrd, Richard Evelyn	American	Flew over North Pole. Flew over South Pole.	1926;1929
		Led several Antarctic expeditions.	1928-1956
Charcot, Jean Baptiste Étienne August	French	Discovered Charcot Island; explored Antarctic.	1903-1910
*Cook, Frederick Albert	American	Attempted to reach North Pole.	1907-1909
*Ellsworth, Lincoln	American	Flights to polar regions by airplane and airship.	1925-1926
*Franklin, Sir John	English	Led three expeditions to the Arctic.	1819;1826;1845
*Greely, Adolphus Washington	American	Arctic explorations; discovery of new land north of Greenland.	1881
*MacMillan, Donald Baxter	American	Explored Labrador, Greenland, and Baffin Island.	1913;1937;1947
Mawson, Sir Douglas	English	Led three Australian Antarctic expeditions.	1907-1931
		Reached South Magnetic Pole.	1909
*Nansen, Fridtjof	Norwegian	First to explore ice fields of Greenland.	1888
		Attempted to reach North Pole.	1895
*Nobile, Umberto	Italian	Flew over North Pole in airship.	1926
*Nordenskjöld, Nils Adolf Erik	Finnish	First to sail Northeast Passage to Asia. Sailed under Swedish flag.	1878-1880
*Palmer, Nathaniel Brown	American	Discovered Antarctic continent.	1820
*Parry, Sir William E.	English	Attempted to reach North Pole.	1827
*Peary, Robert Edwin	American	First to reach North Pole.	1909
*Rasmussen, Knud Johan Victor	Danish	Carried on Arctic explorations.	1902-1912
		First to cross Melville Bay by sledge.	1904
Richardson, Sir John	Scottish	Explored Great Slave Lake region.	1826
Ronne, Finn	American	Explored and mapped Edith Ronne Land.	1947
*Ross, Sir James Clark	Scottish	Located North Magnetic Pole; explored Antarctic.	1831;1839;1843
Schwatka, Frederick	American	Explored Yukon River and led other Arctic expeditions.	1883-1884
*Scott, Robert Falcon	English	Reached South Pole.	1912
*Shackleton, Sir Ernest H.	Irish	Carried on Antarctic explorations.	1908-1916
		Located South Magnetic Pole.	1909
*Stefansson, Vilhjalmur	Canadian	Explored many parts of Arctic.	1904-1918
*Wilkes, Charles	American	Explored Antarctic.	1838-1842
*Wilkins, Sir Hubert	Australian	Flew from Alaska to Spitzbergen.	1928

*Has a separate biography in WORLD BOOK.

U.S. Navy

Roald Amundsen planted the Norwegian flag at the South Pole on December 14, 1911. He traveled by dogsled. In 1958, the British explorer, Vivian Fuchs crossed Antarctica on big snow tractors, *right*.

mountains, he was in India—10,000 miles and 10 years away from home. Alexander explored the Indus River to the Indian Ocean, then turned homeward.

In 325 B.C., Alexander of Macedon died. He was only 33 years old but he had conquered the whole known world. What mattered to later ages was not what Alexander and his men had *conquered*, but what they had *discovered*. Among other things, they discovered that the world was much larger than anyone had imagined. They had discovered the sea route from India to the Persian Gulf, and had learned the secret of the monsoons. These winds in the Indian Ocean blow steadily from the southwest in summer and from the northeast in winter. Once the Greek sailors learned about the monsoons, men could abandon their old methods of coastal sailing and travel directly from Africa to India.

Pytheas. About the time Alexander the Great was making himself master of Asia, another man of the Greek world, Pytheas of Massilia, was exploring northwestern Europe. The Greek colony of Massilia lay on the site of the present-day French city of Marseille. Pytheas was a mathematician and astronomer and, like all scientists, was interested in the universe and the nature of things. He had a particular interest in tides and wanted to study them in the Atlantic Ocean. In 330 B.C., Pytheas sailed from Massilia through the Strait of Gibraltar and into the Atlantic. He set his course north. He sailed along the shores of Spain and north along the western coast of France, steering by sun and stars. He made careful observations of the land and tides. Finally, he came to Britain and Ireland. From Scotland he sailed north until ice blocked his path. When he returned to Massilia he reported what he had seen. His observations convinced him that the moon controlled the tides. He had learned the position of the North Star in relation to the North Pole. Pytheas had observed that the northern seas froze and that in the High North the sun did not set. When he told all this to his fellow countrymen they called him a liar. But Pytheas was not a liar. He was simply the first arctic explorer.

Romans became the next people to rule the ancient world. The explorers of Rome were soldiers and engineers. When Roman soldiers conquered new lands, Roman engineers explored them in search of good sites for roads and forts. The Romans, like the Egyptians, were a land-loving people. Their merchant ships were generally manned by foreigners.

In the time of Julius Caesar, a Greek trader and navigator, Hippalus, sailed from the Red Sea to the Malabar coast. The traders who followed his lead set their courses farther and farther south. About A.D. 100, some of them reached Ceylon. A few years later a Roman trader discovered Cochin China.

Chinese, meanwhile, had been exploring the East as the Phoenicians and Greeks and Romans had been exploring the West. During the last centuries B.C., in the days of the Han emperors, Chinese ambassadors went far afield in search of trade and allies. The greatest of all these ambassador-explorers was Chang Ch'ien. In 138 B.C., Chang traveled from Peking across the Gobi desert to Barkul, and finally over the Tien Shan mountains to Bactria in what is now eastern Iran. There he encountered the descendants of peoples who earlier had been conquered by Alexander the Great. On this remarkable journey Chang Ch'ien learned for the first time about Europe and India. Caravan trains soon were carrying foods and silks and spices from China to India. There they were traded to Arabs who dealt with European merchants. This profitable East-West trade ended with the barbarian invasions of Europe and the breakup of the Roman Empire.

Exploration in the Middle Ages

Everything in Europe was disorganized for hundreds of years after the end of the Roman Empire. Then the barbarian invaders settled down and began to develop a taste for other things besides eating, drinking, and fighting. They, too, began to make discoveries.

Vikings. During the 800's, the descendants of some of the tribes that had settled in the Scandinavian peninsula started to explore. These vikings lived in what is now Norway. They were, like the Phoenicians of old, "strong in the sea."

By now the art of tacking had become well known, and the viking ships were slender and seaworthy. They sailed far over the northern seas, settling first the Faeroe Islands, then Iceland and Greenland. About A.D. 1000, they are believed to have come to the coast of North America. A record of these amazing voyages can be found in the Norse sagas. According to these accounts, the viking chieftains Bjarni, Leif Ericson, and Karlsefini all reached "the lands in the West." They called these lands (1) Helluland, (2) Markland, and (3) Vinland. These places probably were (1) Labrador and Newfoundland, (2) Nova Scotia, and (3) Cape Cod. Unfortunately, no one in Europe was ready to take advantage of these discoveries. America remained unknown to most of the world for almost another 500 years. See VIKING; VINLAND.

Venetians. But if America remained unknown, Asia did not. After the Crusades, trade was resumed with the East. One of the Venetian merchants, Nicolò Polo, wondered if he could buy Chinese and Indian wares directly instead of dealing through the Arabs as most merchants did. Determined to see what he could do, he set out with his brother, Maffeo, in 1255, from a port at the eastern end of the Black Sea. On one of the great caravan routes from China to India, they fell in with messengers of Kublai Khan, the Mongol Emperor of China. The journey took a year. Kublai Khan was delighted with the Polos, and the Polos with Kublai Khan. They stayed 10 years in China and amassed a huge fortune. Then they returned to Europe. Two years later they made another trip, taking with them Nicolò's son, Marco (see POLO, MARCO).

Young Marco Polo became one of Kublai Khan's most trusted servants. In the course of his duties, Marco traveled throughout the Khan's empire. When he returned to Venice he published an account of his travels called *The Adventures of Marco Polo*. This book had a great effect on later exploration and discovery. Those who read it in later years, including Christopher Columbus, decided that Asia was even larger than it really is. Consequently, they thought the Atlantic Ocean must be quite small. If this were true, then the quickest route to the east would be westward across the Atlantic.

It was this line of reasoning that led to Columbus' rediscovery of America.

The Great Age of Discovery

No one knows for sure what caused the brilliant period of discovery that burst upon the world in the 1400's. Some historians explain that it grew simply out of the desire to make money by trading with the Indies. After 1453, the Turks blocked the well-known trade routes to the East. Europeans had to find a new route in order to get the silks, spices, and other luxuries they wanted. Other scholars believe that the great period of overseas exploration began because other nations became jealous of the Italian cities, which had almost complete control of Eastern trade. Some writers stress the desire to convert the heathen to Christianity. Others point out that shipbuilders at this time learned to construct ships that were not only seaworthy and fast, but also could carry large loads. These historians argue that it was simply human nature for men to want to try out their new ships. Regardless of the cause or causes, during the next 200 years Europeans gained a greater knowledge of the world than any other people had ever had.

Strangely, the explorers and discoverers of this age owe their greatest debt to a man who never ventured farther from home than North Africa. This man was Henry the Navigator, a brother of the king of Portugal. From their earliest days, the Portuguese had taken to the sea. But, because of the winds and terrible tides of the Atlantic, they had never gone far beyond their own shores. Prince Henry felt that longer voyages could be accomplished with stouter ships and better instruments. In order to achieve these, he established a school of navigation at Sagres in 1416. Prince Henry encouraged Arab scientists to come to Sagres, and along with them others who had traveled far by land or sea. Soon Sagres became a vast storehouse of geographical knowledge. Prince Henry studied designs for new ships. His shipbuilders designed the *caravel*. This was longer and slimmer than the old ships and carried a greater spread of sail. It was easier to handle and better able to withstand the winds and waves of the Atlantic. The caravel made long voyages possible (see CARAVEL).

The Sea Route to India. By the time Henry the Navigator died, the Portuguese had explored Africa as far south as present-day Ghana. Then, in 1486, Bartolomeu Dias rounded the Cape of Good Hope (see DIAS, BARTOLOMEU). Once this happened, everyone in Portugal felt sure it was only a matter of time until a sea route to India would be established.

Columbus. About this time, Christopher Columbus turned up in Portugal and said that in *his* opinion the shortest route to the East lay not around Africa, but across the Atlantic. Nobody in Portugal was interested, so Columbus went to Spain. He persuaded Queen Isabella that his scheme was sound.

On Aug. 3, 1492, Columbus set sail for Asia *westward* across the Atlantic. On October 12, he sighted land. It was the island of San Salvador, but Columbus was convinced it was Japan. Because *Cipangu*, or Japan, was considered part of the Indies, Columbus called the inhabitants Indians. He discovered other islands and, after a stormy and dangerous voyage, returned in triumph to Spain. "The gate to the gold and pearls is now open," Columbus said, "and precious stones, spices, and a thousand other things may surely be expected." See COLUMBUS, CHRISTOPHER.

News of Columbus' western voyage spread like a forest fire. "Asia can be reached by sailing west," men told one another in awe. The only people in Europe who refused to be excited were the Portuguese. Columbus might have found land in the West, but what had he brought back? Were his ships loaded with gold and spices? They were not. The Portuguese decided to continue with Henry the Navigator's original plan. They would go east by sailing east—around Africa.

Vasco da Gama. The Portuguese expedition around Africa was headed by a favorite of the king, Vasco da Gama. Like Dias, he was known "to have genius with ships." Da Gama left Lisbon in 1497 and sailed to the Cape Verde Islands. From there he set his course directly for the Cape of Good Hope. He was determined to navigate the open seas rather than spend months inching down the coast. After five months of moderately good weather he landed at what is now St. Helena Bay on the southwest coast of Africa.

After leaving St. Helena Bay, the fleet suffered hardship and danger. Each time the men tacked out to sea they hoped that on the return trip the tip of the continent would come into sight. Time after time they were disappointed. The days grew short. Provisions ran low. Terrible storms sprang up. The men became sick with fear and hunger and clamored to go home.

"Until I find information of which I have come to seek, to Portugal I do not return," Da Gama said. The days slipped into weeks, and still the voyage went on. A month passed, and then, when even Da Gama's own courage had reached the breaking point, they took a tack toward the land and the land was not there! They had rounded the cape.

Once around the cape, the seas grew calm and the winds mild. At Malindi, a port on the east coast of Africa well known to Arab traders, they set out across the Indian Ocean. This voyage took nearly a month. The Portuguese had now been gone from home almost 10 months. Many of the men had died of scurvy. Others were too weak to man the sails. It was with both relief and thanksgiving that Da Gama at last sighted land. India! The sea passage to the East had been found. During the following years, many Portuguese ships followed Da Gama's route and even discovered the Spice Islands. They guarded their secret routes, and Portugal grew rich from the profits of their trade. See DA GAMA, VASCO.

The New World. Meanwhile, other men from other nations were following Columbus westward. In 1498, John and Sebastian Cabot sailed from England to Newfoundland. A few years later they explored the coast of North America as far south as Maryland. They still thought they were in some part of Asia. In the early 1500's, it began to dawn on a number of people that "the lands in the west" were not a series of islands off the mainland of Asia. Amerigo Vespucci was one of the first of these. "This land is a whole new world," he said. More and more men believed Amerigo. A German geographer even named these newly discovered lands after him. That is how America got its name. But most people did not care about America. All they wanted was to get through this troublesome land mass and push on to India and the Spice Islands. "America," whatever it was, was merely a nuisance—something that stood in the way.

Spanish Explorations. Then the Spaniards began finding gold in South and Central America. Gold! The whole picture changed. The Spaniards swarmed like angry hornets over South America. Hernando Cortes conquered the rich civilization of the Aztec Indians in Mexico. Vasco Núñez de Balboa crossed the Isthmus of Panama and discovered the Pacific Ocean. Francisco Pizarro explored the western coast of South America and laid waste the great empire of the Incas in Peru. Ponce de León discovered Florida. Two other Spaniards, Pánfilo de Narváez and Cabeza de Vaca, attempted to colonize Florida. Narváez and most of his followers perished, but De Vaca made his way across the Gulf of Mexico to Texas. He was the first white man to see the Mississippi River.

The feverish quest for gold went on. It was spurred by legends of cities built of gold, the famed Seven Cities of Cibola, and tales of El Dorado, the Indian king so rich that he had his limbs daily anointed with gold dust. Francisco Coronado and Hernando de Soto went in search of the fabled Seven Cities of Cibola (see CIBOLA, SEVEN CITIES OF). In the course of this search, Coronado and a band of faithful followers explored vast regions of the Southwest. They discovered the Colorado River and crossed the great plains, but the only gold they saw was ears of Indian corn. In South America, Jiménez de Quesada searched for El Dorado, as did a brother of Pizarro. Francisco Orellana went over the Andes and down the mighty Amazon, but still there was no El Dorado, nor cities of gold.

Ferdinand Magellan was a Portuguese sailor who still believed he could find a good westward passage to India. Like Columbus, he could find no support for his cause in Portugal, where the African route was preferred. But in Spain, Magellan convinced the king that no one had found a western passage simply because no one had gone far enough *south*. On Aug. 10, 1519, Magellan set sail with five ships and 230 men to prove his theory. In November he sighted the coast of South America and followed it south. In March, with winter coming on, he anchored his ships in a little harbor which he called Port St. Julien. By this time rations had become short and tempers shorter. The men were in a sullen and dangerous mood, and pleaded with Magellan to return home. In April they mutinied. Magellan dealt sternly with the mutineers and in August the ships again put to sea.

One day late in October, a great headland rose before them. The fleet rounded this headland, which Magellan called the Cape of Eleven Thousand Virgins, and cast anchor in a bay beyond. Was this just another bay, or was it at last the opening of the long-sought passage? Two ships were sent forward to explore. They returned and reported that they had sailed up the bay for many leagues and found no end. Most important, the flow of the tide was stronger than the ebb. This could only mean that there was an opening towards *another* sea. They had found the passage to the East!

During the navigation of the strait, the supply ship deserted and sailed for home. It was a staggering blow, but Magellan met it with his usual courage. "If we have to eat the leather of the ship's yards," he said, "we will still go on." This time the men agreed. They now had confidence in his leadership.

Across the Pacific. Magellan renamed the Great South Sea upon which the ships sailed the *Pacific*, or *Peaceful*, *Ocean*. For 98 days, Magellan's men sailed across this great empty sea. By now they were half dead from scurvy and hunger. There was nothing left in the stores but rotten sea biscuits. Even these had been eaten by worms and befouled by rats. The drinking water was "green and stinking." The rats were caught and eaten, and finally the leather on the yardarms was soaked in the sea. The men gnawed the leather as they might a bone. Through it all, Magellan remained calm and resourceful, giving what aid and comfort he could to his sick and dying men. Like all great leaders he managed to give them something of his own strength and courage. "Trust in God and the Holy Virgin," he said, "and all will yet be well."

And by a miracle it was. On March 6, 1521, almost 19 months after leaving Seville, the Spaniards sighted the island of Guam. On March 16, the three ships cast anchor off Samar in the Philippines. From there they went to the island of Cebu. There Magellan was killed by hostile natives.

Around the World. The expedition had now lost its leader and only two ships remained seaworthy. Magellan's lieutenant, Sebastian del Cano, took command. For seven months, the Spaniards under Del Cano cruised about the islands of the western Pacific. Finally, in November, 1521, they reached the Moluccas, the Spice Islands. The Spaniards learned to their distress that the Portuguese had reached the Moluccas by way of Africa some years before. But there were enough spices for everyone. They loaded the ships and, in January, 1522, set sail for the Cape of Good Hope and home. A few days out of port one of the two ships sprang a leak and had to be abandoned. On September 8, the remaining ship, *Victoria*, finally cast anchor in the harbor of Seville—the first ship to sail around the world. It is sad that Magellan could not have shared in the triumph. He was without doubt one of the greatest of all navigators (see MAGELLAN, FERDINAND).

Filling In the Globe

Magellan had found a long passage southwest to India. His sailors had sailed around the world. But still man had found no Northwest Passage to the East. This goal continued to drive others to probe the great unknown mass of North America. Giovanni da Verrazano poked along the coast line in 1524. Ten years later Jacques Cartier and 50 years later Sir Martin Frobisher were on the same mission. By 1609, Henry Hudson had joined the search. They, of course, never found the passage. But they mapped large areas of North America. Cartier discovered the St. Lawrence River. And Samuel de Champlain, another French explorer, found the Great Lakes.

Into North America. The countries of Europe were at war with each other almost constantly during the late 1600's and the 1700's. Their rivalry for empire became another force behind exploration. A Frenchman, René Robert de la Salle, was the first white man to look upon Niagara Falls. He moved on to find the water route from Canada via the Illinois and Mississippi rivers to the Gulf of Mexico. By 1675, La Salle claimed much of the interior of North America for France. Louis Joliet, a French fur trader, explored the Lake Superior region. Alexander Mackenzie reached the Arctic Ocean in 1793 and the Pacific Ocean in 1799. From 1804 to 1806, Meriwether Lewis and William Clark explored and mapped the lands beyond the Missouri River all the way to the Pacific.

Exploring the Pacific. By 1750, men had a pretty accurate idea of the outline map of the world. But there were important details still to be filled in. The most important of these was the *Southern Continent.* Since the days of the Greeks, geographers had believed that a great continental land mass lay somewhere in the Southern Hemisphere. They argued that there must be such a land mass to keep the earth in balance. Maps of the Middle Ages show imaginary outlines of this continent. It was called *Terra Australis Incognita*, or the Unknown South Land.

A British naval officer, Captain James Cook, made three voyages to the Pacific Ocean between 1768 and 1776. He sailed around New Zealand. He discovered that the island the Dutch called New Holland was really a small continent, Australia. He crossed and recrossed the South Pacific, discovering and claiming many islands. At one point on his second voyage he sailed south of the Antarctic Circle.

On his final voyage Cook was killed in Hawaii. He had explored the west coast of America to its most northerly point in an attempt to find the western end of the Northwest Passage. He was convinced that if the Northwest Passage existed at all, it lay too far north to be a practical trade route between Europe and Asia. See PACIFIC ISLANDS.

Exploring Darkest Africa. In 1800, Europeans knew little more about Africa than the Phoenicians had known in 500 B.C. Nations engaged in the slave trade were acquainted with the coasts. The English knew a little about Egypt. And the Dutch and English had settled in the regions around the Cape of Good Hope. But, except for stretches of the Niger River, the whole interior of Africa remained a mystery.

During the 1800's this changed. Among the names most dramatically connected with the exploration of Africa are those of David Livingstone and Henry Morton Stanley. Livingstone was a Scottish missionary. In the course of establishing missions he traveled north from Cape Town and westward across the Kalahari desert. Later he crossed Africa by way of the Chobe River to the west coast and the Zambezi to the east coast. He discovered Victoria Falls and later the great lakes of Nyasa and Tanganyika. In the course of his travels he got lost. A New York publisher sent a reporter to find him. This reporter, Henry Morton Stanley, not only found Livingstone but also discovered Lake Victoria and the Congo River. See STANLEY AND LIVINGSTONE.

The 1800's saw many other feats of exploration in Asia, Africa, Arabia, and even America. But not until the 1900's were the last great exploits achieved—the conquest of the Poles.

Polar Exploration

Man had long known that the North Pole lay in the midst of the Arctic Ocean 400 miles from Cape Columbia, Canada. The Arctic is a frozen sea. Tides and currents keep the ice pack in motion, making surface travel hazardous. During the brief Arctic summer, when the sun never sets, the surface of the ice pack melts. Great stretches of water open between the ice floes. Many men braved these waters in search of the Northwest Passage. One of these was Sir John Franklin, who in 1847 perished with his 129 men. Hundreds of men and a dozen ships searched for Franklin. They never found him, but their searches added immensely to our knowledge of the Arctic. In 1905, the great Norwegian explorer Roald Amundsen inched his ship through the elusive Northwest Passage.

Conquest of the North Pole. Finally men realized that the best time for polar exploration was not during the summer, but during the long, dark winter. Temperatures plunge far below zero and savage winds rage across the Arctic in winter. But the sea is frozen solid, providing a route to the pole for men with dog sleds. The man who finally fought his way across the ice to the North Pole was Rear Admiral (then Commander) Robert E. Peary of the United States Navy. The historic date was Apr. 6, 1909.

The South Pole lies in a high, mountain-rimmed plateau in the midst of the frozen Antarctic continent. Between 1820 and 1900, a number of men observed parts of Antarctica's forbidding coasts. In 1902, Captain Robert Falcon Scott of the British Navy explored part of the mainland. In 1908, Sir Ernest Shackleton crossed the mountains and glaciers to within 100 miles of the pole. Three years later, Roald Amundsen and four companions set out for the pole with 52 dogs and 4 sleds. Their expedition was successful. They erected a small tent at the South Pole on Dec. 14, 1911, and ran up a Norwegian flag. A month later, Captain Scott, leading a rival expedition, found the tent and flag still standing. Scott and his four companions perished on their return trip. Scott's diary was found later. It told of the heartbreak and suffering of his tragic expedition.

The Airplane brought a great revolution in discovery. It gave man the ability to cover hundreds of miles in the time it once took him to cover one mile. One of the first explorers to take to the air was Amundsen. In 1925 he used the airplane to explore the Arctic. The next year, after careful preparation, Commander Richard E. Byrd of the United States Navy flew over the North Pole. In 1929, Byrd flew over the South Pole. Since then, the airplane has become the explorers' main vehicle, permitting him to map inaccessible regions with comparative ease.

Under the North Pole. Nearly 50 years after Peary reached the North Pole, the United States Navy achieved another Arctic conquest. On Aug. 1, 1958, the atomic-powered submarine *Nautilus* slipped under the polar icecap off Point Barrow, Alaska. Guided by inertial navigational devices, Commander William R. Anderson pointed the submarine toward the North Pole. He cruised at times as fast as 20 knots. Closed-circuit television plotted the outline of the icecap overhead. At 11:15 P.M. on August 3, the *Nautilus* reached the North Pole, some 400 feet beneath the ice. Two days later the submarine surfaced in the Greenland Sea. The 3,150-mile underwater voyage had carried the *Nautilus* through the back door of the Northwest Passage, from the Pacific to the Atlantic.

The International Geophysical Year (1957-1958) ushered in a new era in exploration and discovery. Sixty-six nations pooled their knowledge and resources to probe the unknown areas of the world about them. The major projects of the IGY included a study of the Antarctic. Sixteen explorer parties from 12 nations covered more than 14,000 miles of previously unexplored Antarctic region. An 11-man team of British explorers led by Sir Vivian E. Fuchs completed the first land crossing of the Antarctic continent. They made the 2,100-mile journey in 99 days, using powerful snow tractors instead of dog sleds. American scientists discovered a mountain range rivaling the size of the Rocky Mountains. Russian scientists made discoveries that tended to confirm the theory that the Antarctic continent is actually two continents, or perhaps even a disconnected chain of mountain islands. See ANTARCTICA; INTERNATIONAL GEOPHYSICAL YEAR.

The New Frontiers

By the end of the International Geophysical Year, man's exploration of the surface of his earth was almost complete. After more than 4,000 years, no large areas of the earth remained for man to explore. But the story of exploration and discovery did not end here. The tremendous advance of science created new horizons that challenged man's exploring nature. Having discovered his own world, man now turned his eyes to the stars.

In February, 1947, an electric impulse was directed to the moon from a radar station in the United States. In less than three minutes, the electric waves rebounded to the earth. Man had made his first contact with the outer universe. In 1957, Russia launched the first man-made earth satellite. The United States soon launched other satellites. Then on April 12, 1961, Yuri A. Gagarin, a Russian air force officer, became the first human to travel in space. He circled the earth at an altitude of about 200 miles. On May 5, 1961, Alan B. Shepard, Jr., a U.S. Navy test pilot, rocketed 115 miles into space.

Gagarin, Shepard, and the other explorers of the Space Age undergo hardships and bravely risk all the dangers of space travel for many reasons. But the first and foremost is simply because they are men. It is man's nature to *search* and *find* and *know*. That is why the history of man is the history of exploration—from the Land of Punt to, perhaps someday, the craters of the moon.

ISABEL BARCLAY

Related Articles. See the list of Explorers and Discoverers in the BIOGRAPHY section of the READING AND STUDY GUIDE. See also the separate articles in WORLD BOOK on each of the continents, such as EUROPE.

See also the following articles:

Antarctica
Arctic
Compass
Diving, Deep-Sea
Fountain of Youth
Geography
International Geophysical Year
Invention
Navigation
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Questions

In what way were the Stone Age people explorers?

Who was the first explorer known to history? How do we know about his voyage?

Why were Alexander's conquests important to mankind?

What three lands in North America do we believe the vikings discovered?

What are four possible reasons for the Great Age of Discovery?

Why is Prince Henry important to discovery?

What mistake did Magellan believe other sailors seeking an India route had made?

What caused sailors to explore the North American coast line in the 1500's and 1600's?

When and how did man make the first contact with the outer universe?

What major findings resulted from exploration of the Antarctic region in 1957-1958?

EXPLORER, an earth satellite. See SPACE TRAVEL.

EXPLOSIVE is a material that bursts with great violence when acted upon by heat or a strong blow. When an explosive explodes, its solids and liquids change to gases and produce great amounts of heat. The hot gases expand violently, because they need more space than the original liquids and solids. Explosions that use large amounts of explosive materials are usually called *detonations.*

With the help of explosives, man tunnels roads through mountains, clears land of stumps, blasts out rocks to clear the way for ships, opens mines, and sends out life lines for shipwreck victims. In war, explosives destroy cities, sink ships, and kill the enemy.

Almost all useful explosives contain the chemical elements carbon, hydrogen, oxygen, and nitrogen. The usual gases formed in an explosion are carbon dioxide, steam, nitrogen, and some carbon monoxide and hydrogen. There are two kinds of explosives: high explosives and low explosives.

A High Explosive changes solids and liquids to gases in an astoundingly short time. The *rate of detonation,* or the rate at which the explosion moves through the explosive, may be as high as 4 miles a second. High explosives include PETN, nitroglycerin, RDX, TNT, and pentolite, a mixture of TNT and PETN. High explosives that are especially sensitive to heat are called *primary explosives.* They are used in *detonators,* or devices to set off explosions.

Low Explosives travel through gunpowder at a rate of about 900 feet a second. They really undergo a kind of rapid burning. When the burning becomes violent, it creates a pressure wave known as a *shock* wave. When the shock waves become intensive enough, they can start a detonation. JULIUS ROTH

Related Articles in WORLD BOOK include:

Ammunition
Artillery
Atomic Bomb
Blasting
Cellulose
Combustion
Cordite
Depth Charge
Detonator
Du Pont Company
Dust Explosion
Dynamite
Fireworks
Forcite
Fuse
Guncotton
Gunpowder
Hydrogen Bomb
Maxim (Hudson)
Mine, Military
Nitrogen
Nitroglycerin
PETN
Picric Acid
RDX
Rocket
TNT
Toluene

EXPONENT. See ALGEBRA (Terms).

EXPORT-IMPORT BANK OF WASHINGTON was established by Congress in 1934 to aid in financing exports and imports between the United States and other countries. The federal government provides capital for the Bank, and the Bank is authorized to borrow from the United States Treasury up to a maximum of $4,000,000,000. It makes direct loans, or insures private loans, to exporters and importers. Most of the Bank's loans have been made to encourage trade between the United States and other American countries. The policy of the Export-Import Bank is to supplement, not compete with, private lenders.

The Export-Import Bank is a federal agency. It is governed by men appointed by the President with the advice and consent of the Senate. G. L. BACH

See also INTERNATIONAL BANK FOR RECONSTRUCTION AND DEVELOPMENT.

EXPORTS AND IMPORTS are the articles shipped from and into a country for sale. *Export* comes from the Latin words *ex* and *portare,* meaning *to carry out. Import,* from the Latin *im* and *portare,* means *to carry in.*

The Pattern of Exports and Imports

Important Factors. A country exports goods under the following conditions: if it is the world's sole supplier of a certain product; if it produces the goods at a relatively lower cost than other countries; or if its own goods are in demand for reasons of quality. A country imports goods that it does not produce, or those which other countries can produce more cheaply. A nation may import goods that are of a finer grade than those it can produce except at very high cost. It may also import products which are thought to be of finer quality, and which appeal to the sense of snobbery in the persons who can afford to pay for them. Measured by value, most imports consist of goods that are not produced domestically, and of products which other countries produce, grow, mine, or manufacture more cheaply.

The climate of the United States is not suitable for growing coffee. For this reason, the United States imports coffee beans, mainly from the Latin-American countries. The United States imports olives from Mediterranean countries. California and Arizona grow some olives, but not enough to supply the whole country at costs competitive with those of foreign producers. Several of the Southwestern states grow dates, but importers bring in large quantities from other countries because growers there can produce them more cheaply. The United States manufactures cameras. In spite of this, it imports cameras from Germany and Japan, because the Germans and Japanese make excellent cameras and enjoy relatively low costs of production. The same reasons account for American imports of such products as Swiss watches, British woolens and chinaware, Irish linens, and French perfumes.

Reasons for Change. A nation's pattern of exports and imports tends to change over the years. This may be due to technological developments. For example, the discovery of synthetic substitutes for such natural products as silk and nitrates eliminates the need to import these products. The development of certain industries within a country allows it to import fewer manufactured goods, and possibly to begin exporting them. Changes may also result from the exhaustion of better grades of raw materials. The United States is nearing this condition in the case of iron ore and petroleum. Sometimes patterns change because of government policies. For example, a lowering of tariff protection would encourage imports from more efficient foreign producers.

Attitudes Toward Exports and Imports

Popular Opinion within a country usually regards national exports with favor. They are the products in which the country excels. They may consist of rich natural resources which are shipped in unprocessed form, or of ordinary natural resources which have been incorporated into industrial products. Many exports, particularly of complex industrial products, are viewed as symbols of national strength. They may be identified with producer interests, or with job-creating activities.

The Exports and Imports of countries throughout the world make them dependent on each other to obtain the basic necessities of life. Frozen meat being loaded on a refrigerated ship in New York will be exported to Europe. The United States, in turn, imports materials and goods that it needs.

Port of New York Authority

In a way, exports make other countries dependent on the exporting country, and provide the principal means for a nation to develop financial claims on the rest of the world.

The majority of people in most countries merely tolerate imports other than those products not available at home. In the popular view, imports are produced by inferior labor working for extremely low wages. People feel that imports subtract from job opportunities at home, depress domestic levels of living, expose the national welfare to fluctuations in the supply of foreign-controlled goods, and drain money from the domestic market to foreign countries.

Economists, in contrast with the general public, usually believe that imports are more important than exports. To the economist, exports are only a means used to achieve the principal goal of foreign trade, which is to import. The economist describes a nation's level of living as equal to domestic production plus imports minus exports. With unchanged domestic production, a country's long-run economic welfare will improve with all measures that decrease the quantity of exports required to pay for desired imports. Policies that expand exports without increasing imports tend to depress a country's level of economic well-being.

Government Policies

Export Promotion. Most governments artificially promote the nation's exports. They may do this by direct government subsidy. For example, the United States exports raw cotton at a price about one fifth below the government-fixed domestic price. The government pays a subsidy to cotton exporters to cover the difference between the lower export price and the higher domestic price. This arrangement handicaps domestic textile mills, which must compete with foreign mills that can buy the subsidized cotton. American mills then pressure Congress to strengthen them, through protective tariffs on imported textiles, against a competitive disadvantage that flows directly from the government export-promotion policy.

Another artificial arrangement to promote exports consists of special tax incentives. The government may exempt certain export industries from a long list of taxes which all other businesses must pay. This exemption not only enables these industries to produce more, but also helps them overcome the burden of tariff policies in other countries.

A third example of government activity involves a complex system of exchange rates. A government may buy foreign money from its exporters at a home-currency price well below the price at which they sell the same money to their own importers. For example, a Latin-American government may pay wheatgrowers three pesos for each American dollar's worth of wheat exported to the United States. The importers in the country may not be able to buy the dollars they need to pay for importing American goods at less than five pesos for every dollar's worth. This really amounts to a slightly disguised tax on the importers. It also provides the government with an easy way to control specified exports. The same government may decree that exporters of hides and skins may receive four pesos for every American dollar's worth of exports. This works out as a subsidy of one third more for the hide and skin exporters as compared with the wheat exporters.

Import Restrictions are even more elaborate and complex than those used to promote exports. The most common restrictive device is the *tariff*, a tax on imports. In the United States, most restrictions on imports are of this type. In many other countries, the *import quota* plays a major role in import restriction, and is generally more effective. The more efficient foreign producers may be able to lower their costs enough to overcome tariff duties. But no degree of superior efficiency can help foreign producers when they face a rigid restriction on the number of items that may be imported.

Foreign exchange control can also restrict imports effectively. Such a control regulates the kind and quantity of permissible payments in foreign exchange that importers may make to foreign suppliers. The government permits certain imports into the country when it allows importers to make foreign payments for them. Other goods are barred from the country if the authorities do not allow payments for them. As a rule, importers must pay tariff duties on the merchandise in question, as well as observe foreign exchange restrictions.

Unexpected costs and delays at the customs office form still another type of import restriction. For example, a customs officer may place an arbitrarily high value on certain imports, even though the documents clearly state the cost of these goods. Tariff duties levied on such arbitrary valuations impose unexpected costs on importers, and thus discourage imports.

Two trends seem to be developing with respect to government restriction of imports. In the economically more advanced countries, such as the United States and the nations of Western Europe, the trend favors reduction of import restrictions. More and more people feel that a widening of market areas, through a reduction of import restrictions, promotes economic growth and productive efficiency. Modern and technologically advanced industries worry less about economic security than do the more static industries. They rely instead on product research and improved management techniques for strength and competitiveness.

The less economically developed countries in Africa, Asia, and Latin America tend to rely increasingly on import restrictions. They feel that protection is necessary for the growth of their infant industries. They point out the importance of protection in the past growth of industry in such nations as the United States. VIRGIL SALERA

Related Articles. See the sections on Trade in various country articles, such as FRANCE (Trade). See also the following articles:

Balance of Trade
Customs Duties
Exchange
Foreign Trade
Free Trade
Reciprocal Trade Treaty
Tariff
Trade

EXPOSITION. See FAIRS AND EXPOSITIONS.

EXPOSITION, in literature. See LITERATURE (Kinds).

EXPOSITION PARK. See LOS ANGELES (Interesting Places to Visit).

EXPRESS SERVICE. See RAILWAY EXPRESS AGENCY; AIR MAIL AND AIR EXPRESS; WELLS, FARGO & COMPANY.

EXPRESSIONISM is a movement in painting, sculpture, and other arts, that began in the late 1800's. It puts prime emphasis on the artist's expression of his inner feelings and experiences. Expressionists reject realism and idealism, and distort nature if necessary. This trend appears in all phases of art, from African Negro sculptures to the latest paintings.

Expressionism in painting is largely based on the works of Vincent van Gogh and Paul Gauguin. Artists such as Henri Matisse and Pablo Picasso have gone through an Expressionist phase. Georges Rouault was a leading French Expressionist. German artists led the movement for many years. They included Max Beckmann, Wassily Kandinsky, Ernst Ludwig Kirchner, Oskar Kokoschka, and Emil Nolde. An American movement, *abstract expressionism*, developed in the works of Willem de Kooning, Franz Kline, and Jackson Pollock. PETER SELZ

Paintings by De Kooning, Gauguin, Kandinsky, Kokoschka, Matisse, Picasso, Rouault, and Van Gogh appear in color in the PAINTING article.

EXPRESSWAY. See ROADS AND HIGHWAYS (Kinds).

EXTENSION, *ehks TEN shun*, in physics, is that property of matter by which it occupies space. Even the tiniest material object occupies a certain amount of space and has dimensions of length, breadth, and thickness. A line without breadth is purely imaginary. The thinnest sheet of paper has a certain thickness. The two most important units used to measure dimensions of extension are the English yard and the international meter. The term extension is also used by physicists to refer to the increase in length brought about when an object is stretched, as in tension. LOUIS MARICK

EXTENSION SERVICE is a form of adult education that many universities and colleges offer in addition to their regular programs. Course study includes vocational training and courses to help business and professional persons keep up with new developments in their fields. Extension education may or may not lead to a degree. It is usually directed toward students who are not able to attend the university proper. A person who lives many miles from a university campus might take a course of study by mail. Or he might take part in extension classes organized in his community, or listen to lecturers sent out by the school. Today, colleges and universities in every state maintain extension divisions. They use motion pictures, radio, and television in their courses.

In England, the first work in popular adult education was done by nonuniversity organizations. The church and the Mechanics' Institutes made some attempts during the early 1800's. But by 1845, the great English universities had entered the field. The first university extension lectures were formally begun by fellows of Cambridge University in 1873.

In the United States, too, the universities were not the first organizations to study methods of adult education. The *lyceum* appeared in 1826. It provided public lectures, concerts, and entertainments in many communities. Half a century later, its logical successor, the *Chautauqua system*, offered lectures and correspondence courses, particularly in rural areas. The types of education offered ranged from the shallow and haphazard to the scholarly and authentic.

The Philadelphia Extension Society made its appearance in 1883. In 1888, a group of university professors under the leadership of Melvil Dewey suggested that the American Library Association undertake extension education. A year later Columbia University decided to offer extension courses. By the early 1900's such courses had become an established feature of American universities. Morse A. Cartwright

See also Armed Forces Institute, U.S.

EXTENSOR. See Arm.

EXTERMINATOR. See Fumigation.

EXTINCT ANIMAL is an animal that lived on earth but has died out. Some extinct animals, including dinosaurs, are *prehistoric*. They lived more than 5,000 years ago, before man learned to write. Other extinct animals, such as the dodo, died out in recent times.

Most extinct animals died out gradually, as a result of changes in the *environment*, or surroundings, to which they could not adjust. They became fewer in number, and finally disappeared as conditions became increasingly bad for them. But some, including the passenger pigeon, were killed off by hunters.

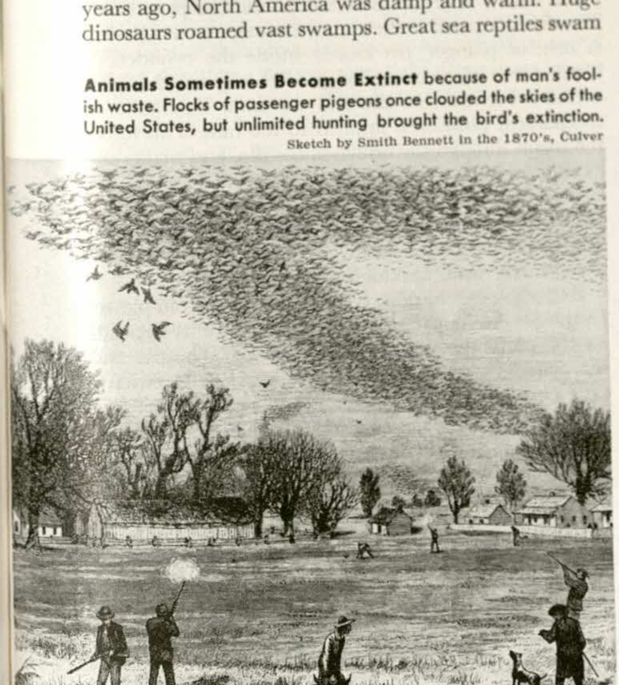
Fossils, or remains and traces left in the rocks by plants and animals, show that animals *evolve*, or change slowly, over millions of years. Sometimes evolution keeps up with changes in the environment; sometimes it does not. When it does, early types of animals evolve into later types. The early forms become extinct, and their descendants replace them. For example, the early horse, *Hyracotherium* (or *Eohippus*), lived about 60,000,000 years ago. It gave rise to later horses, including *Merychippus* which lived about 30,000,000 years ago. The living descendant of these extinct animals is the modern horse, *Equus*.

Sometimes, the earth changed so rapidly that animals did not evolve fast enough to adjust to the changes.

Then they became extinct, and were replaced by other kinds of animals. For example, about 100,000,000 years ago, North America was damp and warm. Huge dinosaurs roamed vast swamps. Great sea reptiles swam in warm oceans. About 60,000,000 years ago, the Rocky Mountains arose. The climate became drier and colder. The dinosaurs and sea reptiles could not live in the new environment and became extinct. Mammals, which were better suited to the new conditions, replaced them.

Animals Sometimes Become Extinct because of man's foolish waste. Flocks of passenger pigeons once clouded the skies of the United States, but unlimited hunting brought the bird's extinction.

Sketch by Smith Bennett in the 1870's, Culver



Two periods of great extinction of animals occurred on earth. The first was when the Rocky Mountains rose. The second was about 1,000,000 years ago, when the Ice Age began. The Northern Hemisphere became very cold. Man appeared at this time and learned to hunt. Scientists do not know whether some animals became extinct at this time because of man, or because of the climate changes. In North America, we know that man at least helped in the extinction of elephants, mastodons, and a kind of bison. Samuel Paul Welles

Related Articles in World Book include:

Aepyornis
Auk
Aurochs
Bird (Extinct)
Dodo
Evolution
Fossil
Geology (Outline of Earth History)
Ice Age
Moa
Parakeet
Passenger Pigeon
Prehistoric Animal

EXTINCTION METER. See Light Meter.

EXTORTION is the attempt to obtain money from someone by threatening to make a criminal charge against him. The payment, or bribe, is often called *hush money*. Extortion originally meant the crime of obtaining payment by threatening to disclose misuse of official power. If an official commits the crime, we would now call it *bribery*. If a private person does it, we would call it *blackmail*. Both crimes are considered kinds of extortion, and are punishable by prison or fine, or both. Fred E. Inbau

See also Blackmail; Bribery.

EXTRA. See Newspaper (Newspaper Terms).

EXTRACT is a substance obtained by extracting, or taking out, the juices of meats or various plants, herbs, and flowers. The juice extracted is a *concentrate*, or a strong form of the flavor of the product from which it is taken. Extracts are used as flavorings in cooking and as antiseptics in medicine.

Two common ways of obtaining extracts are the pressure method and the decoction method. In the *pressure* method, the extract is squeezed or pressed out of the product. In the *decoction* method, the product is dipped or steeped in a boiling liquid for a number of hours. After the liquid cools, it is strained and reduced to a paste, or *extract*, by evaporation.

Popular flavoring extracts used in cooking include vanilla, lemon, almond, and the meat extracts. Beef extract is the most popular of the meat extracts. It is used to improve the flavor of soups, stews, and sauces. It also makes a beverage or clear soup called *bouillon*. Beef extract is prepared by the decoction method. About 35 pounds of meat are required to make one pound of concentrated beef extract.

An extract of a drug is called a *tincture*. Tincture of iodine is a frequently used medical extract. Other medical extracts are oil of wintergreen, of peppermint, and of cloves. These extracts are usually mixed with alcohol.

Cosmetic extracts, or *essences*, are used in making perfumes, toilet soaps, tooth paste, and hair oil. Some better-known cosmetic extracts are ambergris, benzoin, castor, musk, and balsam. James A. Beall

See also Essence; Meat Extract; Perfume; Tincture.

EXTRADITION, *EHKS truh DISH un,* is the handing over by one state or country to another of persons accused of crimes. The word *extradition* comes from the Latin *ex,* which means *out of,* and *traditio,* which means *delivering up.* In early times, people who committed crimes were safe when they escaped to another country. In fact, governments often sent people out of the country as the only penalty for serious crimes. But in the late 1700's, nations began to arrange extradition treaties among themselves. Such treaties provide that people accused of certain crimes must be surrendered to the country where they committed the crimes, when that country demands their return. Ordinarily, people cannot be extradited for political crimes. The United States holds extradition treaties with more than 40 countries. The Constitution of the United States provides that any state shall on demand extradite an accused person, but governors may use discretion in obeying this law. See also Asylum. Critically reviewed by Telford Taylor

EXTRADOS is the outer curve of an arch. See Arch.

EXTRASENSORY PERCEPTION, often abbreviated to ESP, means to be aware of something or to know about it without the use of the known sense organs. That is, a person perceives something without actually seeing, hearing, touching, smelling, or tasting it. Probably everyone has had the experience of seeming to know what another person was thinking. This may be called *telepathy.* And everyone probably has correctly guessed that some event about which he had no direct knowledge has happened. This may be called *clairvoyance.*

Scientists do not know whether extrasensory perception is the result of chance. They have conducted many experiments to find out. The best-known experiment involves the use of 25 cards. One of five shapes (circle, plus, wave, star, or rectangle) appears on each of the cards. They are placed face down, and the person tries to guess which shape is on the reverse side. By chance a person would guess correctly five times out of 25 tries. Many people trying this experiment find that their subjects do not show extrasensory ability, but do come close to chance. Many psychologists do not believe extrasensory perception exists. Russell M. Church

See also Clairvoyance; Mind Reading; Telepathy.

EXTRATERRITORIALITY, *EHKS truh TEHR rih TOH rih AL uh tee,* is a legal term for the privilege granted to some persons living in foreign countries. It allows them to remain under the authority of the laws of their own land. The word *extraterritoriality* comes from two Latin words, *extra,* which means *out of,* and *territorium,* which means *territory* or *jurisdiction.* Ambassadors, ministers, and other diplomatic agents are given this privilege. They cannot be arrested for breaking the laws of countries to which they are sent. But if they do violate local laws, their governments may be asked to recall them.

Extraterritoriality is also arranged by treaties between countries. The Western Powers formerly had such treaties with many countries of Africa and Asia. Under the treaty terms, American and European citizens could not be tried in the courts of foreign countries where they were living. This made a one-sided arrangement and the privilege was abused. Payson S. Wild, Jr.

See also Diplomacy.

EXTREME UNCTION, *UNGK shun,* is a sacrament of the Catholic Church administered to a person who is in danger of death from sickness or from accident. It is not administered before surgical operations or to children who have not reached the age of reason. The sacrament is in accordance with James 5:14. The priest makes the sign of the cross with holy oil upon the eyes, ears, nose, mouth, hands, and feet. At the same time he prays and asks for mercy for the soul of the sick person. See also Sacrament; Viaticum. Fulton J. Sheen

EXTROVERT, when used nontechnically, means a sociable person who makes friends easily. In psychiatry, the word has a somewhat different meaning. The Swiss psychiatrist Carl G. Jung defined *extroversion* as turning the interests and energies of the mind toward events, persons, and things of the outer world.

In normal people, extroversion is counterbalanced by introversion, and a wholesome balance is maintained between the two tendencies (see Introvert). But in an extrovert, the tendency toward extroversion is greater than the tendency toward introversion. According to Jung, if this imbalance becomes extreme, a mental conflict arises between the two tendencies, and neurosis may result (see Neurosis). Charles Brenner

See also Jung, Carl Gustav.

EXTRUSION is the process of giving a specific shape to a piece of solid material by forcing it through a metal die. The materials most commonly extruded include metals, plastics, rubber, and ceramics. This article discusses metal extrusion, but the extruding process is essentially the same for all materials.

Metal can be extruded into many shapes simply by changing the shape of the *orifice,* or opening, in the die. To make a round rod by the extrusion process, a die is made with a hole the same size as the completed rod. The die is fastened to the end of a strong metal cylinder. A *ram,* or plunger, fits loosely inside the cylinder. A blank piece of metal called a *billet* is inserted in the cylinder between the die and the ram. Hydraulic or mechanical pressure is applied to the ram. This forces the metal through the orifice in the die, and makes the extruded rod. A cutting tool on the outside of the die cuts the extruded rod from the machine. A *reverse extrusion* is made when the cylinder has no orifice. The ram forces the metal backward between the ram and the cylinder wall, making a cup-shaped object.

Extruding can be done with hot billets or cold plates. In the *hot process,* the temperature of the billet depends on the particular metal to be extruded. The die and the cylinder are heated with either gas or electricity. *Cold extrusion,* or the *Hooker process,* uses cup-shaped metal blanks to make small cartridge cases and thin-walled tubes. The metal is forced through an orifice in a die as in the hot process. *Impact extrusion* is similar to cold extrusion, except that it makes a reverse extrusion.

Extrusions are regularly made from the following metals and some of their alloys: aluminum, copper, lead, magnesium, nickel, tin, and zinc. The higher the melting point of a metal or alloy, the more difficult it becomes to extrude. William G. N. Heer

See also Die and Diemaking; Iron and Steel (Extrusion); Plastics (How Articles Are Made from Plastics); Rubber (Compounding and Mixing); Wire (How Wire Is Made).

EYCK, HUBERT VAN. See Van Eyck, Jan.

EYE

Our eyes are our most important sense organs. We should take good care of them and have them examined regularly. Doctors use many different kinds of tests to find whether our eyes are healthy.

EYE is our most important organ for finding out about the world around us. We use our eyes to gain knowledge, to appreciate the beauty of nature, and to enjoy literature and painting. Our eyes help us carry on almost all the activities of daily life.

The eye measures only about an inch across. But it is the only sense organ that can overcome great distances. Touch and taste require actual contact with an object. We can smell objects some distance away, but the nose must come into contact with odor-causing particles that the object gives off. We can hear some sounds from several miles away. But the ear requires mechanical aids, such as the telephone or radio, to hear farther than that. The eye makes the visual world almost limitless. We can see light from stars many trillions of miles away. This light may have traveled through space for thousands of years.

The eye can see very bright light and very dim light. In daytime, we see the sun, which is millions of times brighter than this page. Yet on a clear, dark night, we can see the light of a match several miles away. With an upward glance, we can see a large part of the universe in the night sky. We can also see objects as small as the point of a pin. Various instruments help us see even better. With the aid of a microscope, for example, we can see red blood cells so small that 60,000 would fit on the head of a pin.

Care of the Eye

If you want your eyes to give you a lifetime of good service, you must take care of them. Children should have vision tests each year. Every adult over the age of 40 needs a thorough eye examination at least every two years. These examinations may uncover eye defects and diseases.

Blurred vision or pain in the eye may indicate disease. Eye diseases also may cause unusual redness, excessive watering, and irritation or itching of the eye. You should see a doctor if any of these symptoms lasts for more than a day or two.

Preventing Eye Damage. Be careful to protect your eyes from accidents. Accidents that cause blindness may result from carelessness with fireworks, stones, sharp sticks, toy arrows, and BB guns. Children, athletes, and other active persons who wear glasses should use those made from unbreakable glass or plastic. Workers in shops where chips of metal or other material fly about should wear protective face shields or safety glasses. Protective shields or glasses should also be worn by persons handling strong chemicals.

Light helps us see, but too much light can harm the eyes. Looking directly at the sun can damage your eyes and cause partial blindness. Never keep your eyes open under a sun lamp, because the powerful light may burn the outer layers of the eyes. Men who do arc welding, who work near industrial furnaces, or who do other work near brilliant light, should wear special protective eye shields. These shields reduce the amount of light that reaches their eyes.

Many chemicals can cause severe damage to your eyes. Household ammonia, lime, and strong cleaning solutions should be used with great care. If any chemical touches your eye, wash it out immediately with large amounts of water.

Anything that gets between the eyelid and the eye is called a *foreign body*. You can usually remove such an object by flushing it out with water, or by using the corner of a clean handkerchief. Do not rub your eye. Rubbing may make the foreign body scratch it severely. If you cannot remove the foreign body, or if it lies on the center of your eye, consult a doctor. See FIRST AID (picture, Other Needs for First Aid).

Using Your Eyes Properly. Vision depends partly on the amount of light present. A small sign a block away is harder to read at twilight than at noon. To read comfortably, you need good light. But too much light, or light that glares directly into your eyes, can be uncomfortable. Extra light may be needed for difficult tasks. Contrasting colors also make it easier to see. For example, sewing black thread on white cloth is easier than sewing black thread on black cloth. See LIGHTING.

Good habits are important in using your eyes. When you read, hold the printed page at least 14 inches from your eyes. The muscles that focus the eyes for reading become tired after long use and do not work properly. Eyestrain and blurring may result from improper focusing. When you read for a long period, relax your eye muscles occasionally by looking at a distant object for a short time. When you watch television, sit across the room from the screen, rather than only 3 or 4 feet away. The room should not be completely dark.

Vision Tests. There are several kinds of vision tests. The test for *visual acuity*, or sharpness of vision, is usually given with a standard chart that consists of rows of letters. The letters in each line are smaller than those in the line above. From a distance of 20 feet, the patient reads aloud the letters that he can recognize. He reads with one eye covered, then with the other eye covered. If he can read letters of the size normal for a person 20 feet away, his vision is expressed as 20/20. If, at 20 feet, he can read only the letters that the normal eye can see at 40 feet, he has 20/40 vision. Some persons have sharper eyesight than normal. A person who can see letters from 20 feet that the normal eye can see only from 15 feet has 20/15 vision.

Other defects in vision that may be tested with charts of various kinds include *astigmatism*, which results in blurred vision, and *color blindness*, or the inability to see certain colors.

Doctors use an instrument called an *ophthalmoscope* to examine the inside of the eye. The ophthalmoscope shows conditions within the eye as clearly as if they were on the surface. It also allows the physician to examine the blood vessels in the eye. The condition of these vessels reveals certain general conditions of the body's circulatory system. For this reason, doctors examine the inside of the eye during a routine physical examination. See Ophthalmoscope.

Parts of the Eye

The Eyelids are movable curtains in front of the eye. They consist of three main layers: (1) the skin; (2) the muscles that open and close the lids; and (3) the *conjunctiva*, a membrane that lines the eyelids and covers part of the eyeball. Closing the eyelids, as in blinking, protects the eyes from injury and regulates the amount of light that enters the eyes. Blinking also wipes the surface of the eyes clean, and keeps a layer of a slightly salty fluid over the front of the eyes. This fluid, the *tears*, is produced in *lacrimal glands*, or tear glands, that lie under the outer part of the upper eyelid (see Tears). Two small tubes, the *lacrimal ducts*, open at the inner corner of each eyelid. They continually drain the tears from the eye into the nose. Most persons blink an average of 25 times a minute.

Persons of the Mongoloid races have a fold of skin that extends from the upper eyelid toward the nose. This fold, the *epicanthus*, gives the characteristic slanting appearance to their eyes.

The *eyelashes* act as a protective screen that keeps tiny foreign particles out of the eye. The *eyebrows* and the jutting edges of the facial bones form a protective wall around the eye.

The Eyeball is a sphere that lies buried in fat inside the *orbit*, or space in the skull surrounded by bony walls. Each eyeball has six *ocular muscles* attached to it. These muscles move the eye. The conjunctiva covers the front of the eyeball, except for the *cornea*. The cornea is the clear tissue over the colored part of the eye. The conjunctiva contains many nerves which warn us if dust or other particles get under the eyelids. The center of the eyeball contains a transparent jelly-like substance called the *vitreous humor*. The surface of the eyeball consists of three basic layers: (1) the sclera, (2) the middle layer, and (3) the retina.

The Sclera is the outer layer of the eyeball. It consists of tough, white tissue that serves as the supporting framework of the eye. At the front of the eye, the sclera becomes the clear and transparent cornea, through which light enters. The cornea measures about ½ inch in diameter, and is shaped like an igloo, or a ball cut in half. The *anterior chamber* is a small space behind the cornea. It contains a clear watery fluid called the *aqueous humor*.

The Middle Layer of the surface of the eyeball has three parts: (1) the choroid, (2) the ciliary muscle, and (3) the iris. The *choroid* makes up about four fifths of the middle layer. It lies toward the back and sides of the eyeball. The choroid contains most of the blood vessels that nourish the eye.

Toward the front of the eyeball, the choroid becomes the *ciliary muscle*. This muscle is connected by fibers to the *crystalline lens*, a transparent structure about the size and shape of a small lima bean. The muscle keeps the lens in place and controls its shape.

At the very front of the eye, the middle layer becomes the *iris*, a thin curtain of tissue in front of the lens. Light passes through the *pupil*, a round hole in the iris. The pupil looks like a black circle. Two sets of muscles in the iris change the size of the pupil. This controls the amount of light that enters the eye. When examining the inside of the eye, doctors sometimes use drugs, such as atropine, in eye drops to *dilate*, or enlarge, the pupil. The amount and location of pigment in the iris determine whether the eye looks blue, green, gray, or brown.

The Retina is the inner layer of the eyeball. It occupies about four fifths of the eye, toward the rear of the eyeball. The retina touches the choroid. It consists of three main layers of cells: (1) *nerve* cells toward the central cavity, (2) *light-sensitive* cells in the middle, and (3) *pigment-containing* cells toward the outside near the choroid. Light must pass through the layer of nerve cells to reach the light-sensitive cells.

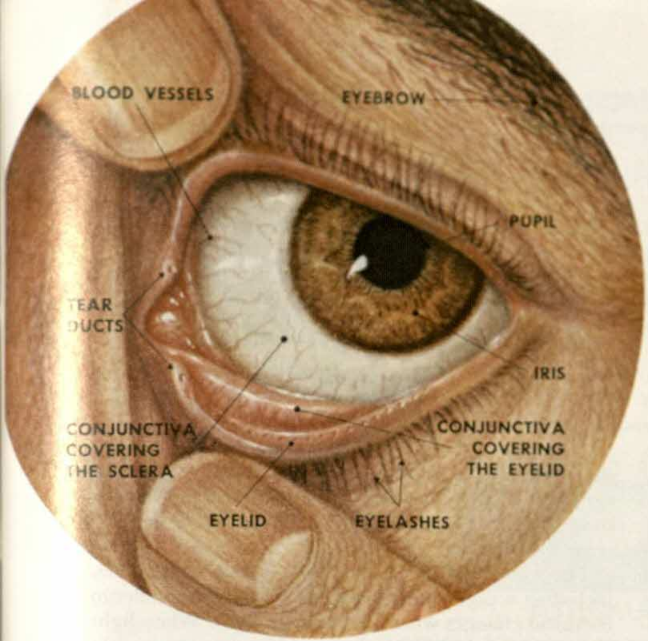
The retina has two kinds of light-sensitive cells. These are the long, thin *rods* and the wider *cones*. The rods lie toward the edges of the retina, and the cones are near the center. Nerve fibers attached in front of the rods and cones come together from all parts of the retina to form the *optic nerve*. This large nerve passes through the retina and other layers of the back of the eyeball, and goes to the brain.

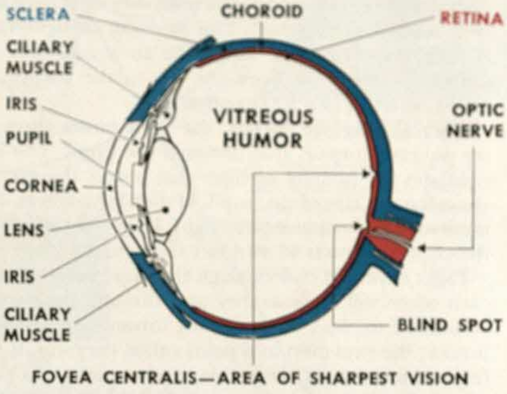
How We See

Vision is the ability of the eye to form an image of an object and send the image to the visual centers of the brain. This process is like taking a picture with a camera. Light rays from the object pass through the cornea, the aqueous humor, the pupil, the lens, and the vitreous humor, and finally reach the retina. When light hits the light-sensitive cells of the retina, they

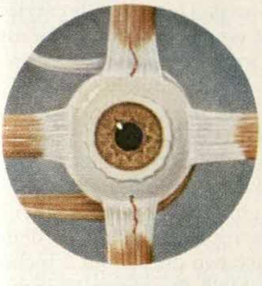
PARTS OF THE EYE

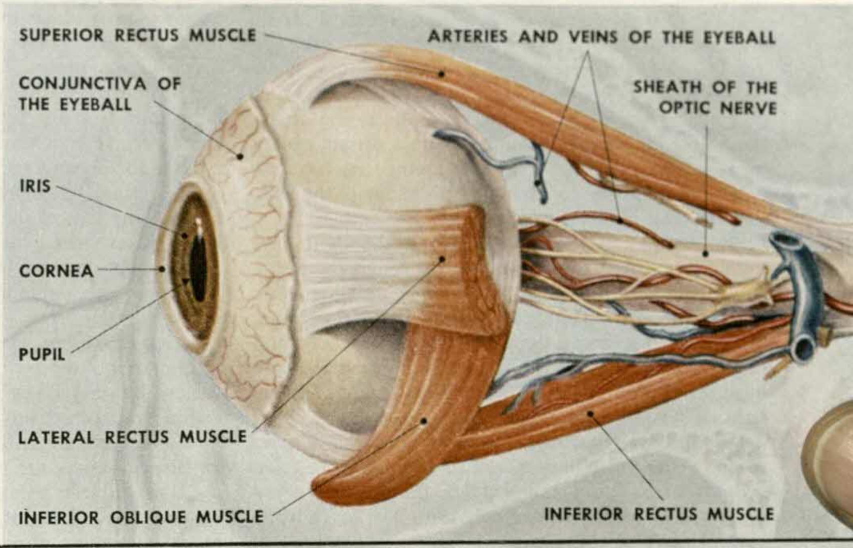
The human eye is a complex organ. The part we normally see, *left*, is only about one sixth of the complete eye, *below*.


BLOOD VESSELS
EYEBROW
PUPIL
TEAR DUCTS
IRIS
CONJUNCTIVA COVERING THE SCLERA
CONJUNCTIVA COVERING THE EYELID
EYELID
EYELASHES

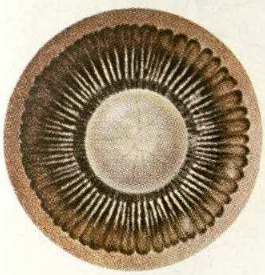


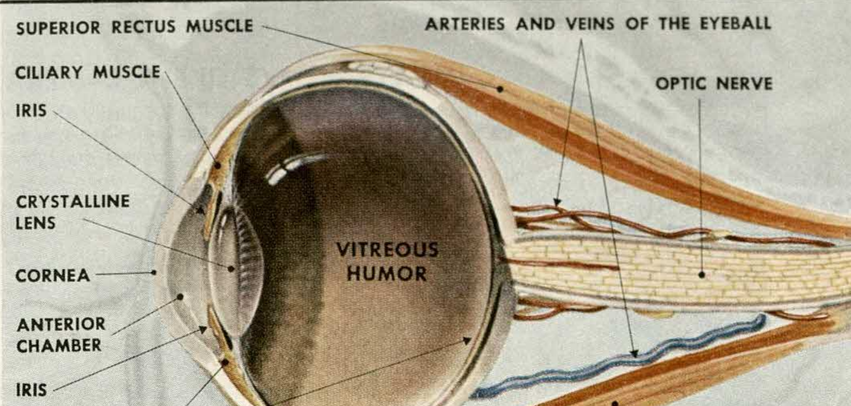
Side View of the Eyeball, *right*, shows the blood vessels and nerves of the eye. A bundle of nerve fibers forms the optic nerve, which extends from the back part of the eyeball to the brain. Ocular muscles, *below*, let a person move his eye up, down, and from side to side.





Cutaway of the Eyeball, *right*, shows the jellylike substance that fills the eyeball. A clear bowl-shaped cornea covers the front. The lens, *below*, is shown from the rear. The large, dark area around it is the *ciliary body*, to which the lens is attached by ligaments.





Courtesy of Abbott Laboratories International Company. Color reconstructions by Arnold Ryan Chalfant in consultation with Thomas S. Jones, Emeritus Professor of Medical and Dental Illustration, The Professional Schools, University of Illinois at Chicago.

stimulate the nerve cells. The optic nerve carries the messages from the retina to the *visual cortex*, or seeing part of the brain.

Focusing and Accommodation. When light rays hit the curved surface of the cornea, they are partially bent toward each other. This bending of light rays as they pass from one substance to a substance of different density, as from the air to the cornea, is called *refraction* (see REFRACTION).

After leaving the cornea, the light passes through the aqueous humor, then through the pupil. The iris regulates the amount of light that enters the eye by changing the size of the pupil. If dim light enters, the pupil expands to admit more light. If the light is bright, the pupil contracts to shut out unnecessary glare.

Light rays that pass through the pupil bend toward each other still more as they pass through the curved surfaces of the lens. After passing through the vitreous humor, the rays meet at a point called the *focus*. If the focus is located on the retina, a clear image is produced. But if the light rays meet behind or in front of the retina, the image will be blurred.

Light rays coming to the eye from a distant object are almost parallel. Those from an object near the eye are *divergent*, or spread out. The lens cannot focus divergent light rays from a nearby object, and parallel light rays from a distant object, on the retina at the same time. To change the focus from a distant object to a nearby one, the lens must change its focusing power. This is done by changing the shape of the lens, and is called *accommodation*.

The Image on the Retina. When the light rays finally reach the retina, they pass through the nerve cells to reach the rods and cones. The cones lie mainly in the *macula*, a small area near the center of the retina. They are less sensitive than the rods are, and respond only to fairly strong light. The cones in the macula do most of our seeing in daylight or fairly bright artificial light. They produce clear, sharp images with good detail, and are responsible for color vision (see COLOR [Color Vision]). In the center of the macula is the *fovea centralis*, a small depression. Here the layer of nerve cells over the cones is extremely thin. The fovea is the area of sharpest vision.

RETINA

The retina at the back of the eyeball contains tiny rods and cones that are sensitive to light. Light rays form small dots on it. These blend into one image, much as do the dots in a halftone engraving, left.

Cones allow us to see colors and sharp details in bright light.

Rods allow us to see in dim light. They do not see colors.

The area of the retina outside the macula contains the rods. These cells are extremely sensitive, even to very dim light. But they produce a rather blurred image, and do not provide color vision. They lose their sensitivity in bright light.

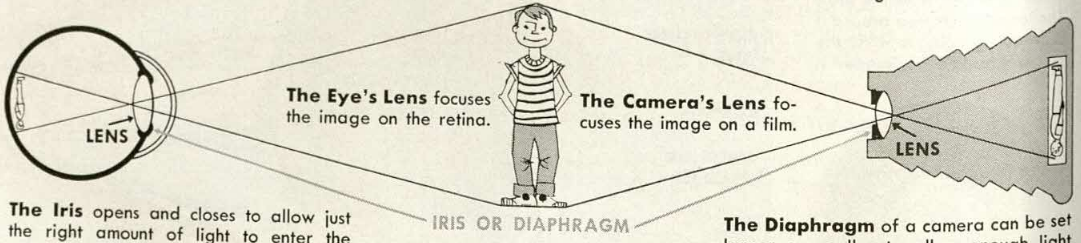
The rods and cones contain certain substances, including a pigment called *visual purple*, that undergo chemical changes when they absorb light. When light reaches the retina, these chemical changes occur within the light-sensitive cells. They cause electrical impulses to pass along the nerve fibers attached to the rods or cones. These impulses move along the optic nerve to the brain.

The image is formed on the retina much as a picture is produced on the film of a camera. The rods and cones receive individual rays of light from different parts of the object seen. Each cell records a dot of light on the retina. These dots of light blend to form a single image. The lens of the eye, like other double-convex lenses, inverts the light rays, so that the image on the retina is upside down (see LENS). This image is carried along the optic nerve to the visual cortex of the brain. In the visual cortex, the image enters the person's consciousness right side up, and is actually "seen."

The area of the retina where the optic nerve leaves the eye has no rods or cones. It is the only part of the retina that is insensitive to light, and causes the *blind spot*. An object is invisible if its image falls on this area. In general vision, the brain fills in this blind spot with the same subjects seen in surrounding areas. To demonstrate the blind spot, place two dots about 5 inches apart on a piece of paper. Hold the paper 12 inches

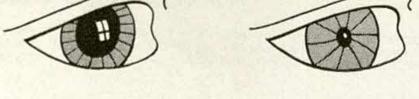
THE EYE WORKS LIKE A CAMERA

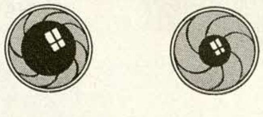
The eye and the camera obtain pictures in similar ways. Each has a lens to focus the image. The iris of the eye and the diaphragm of the camera each regulate the amount of light received. The retina of the eye and the film of the camera are each sensitive to light.

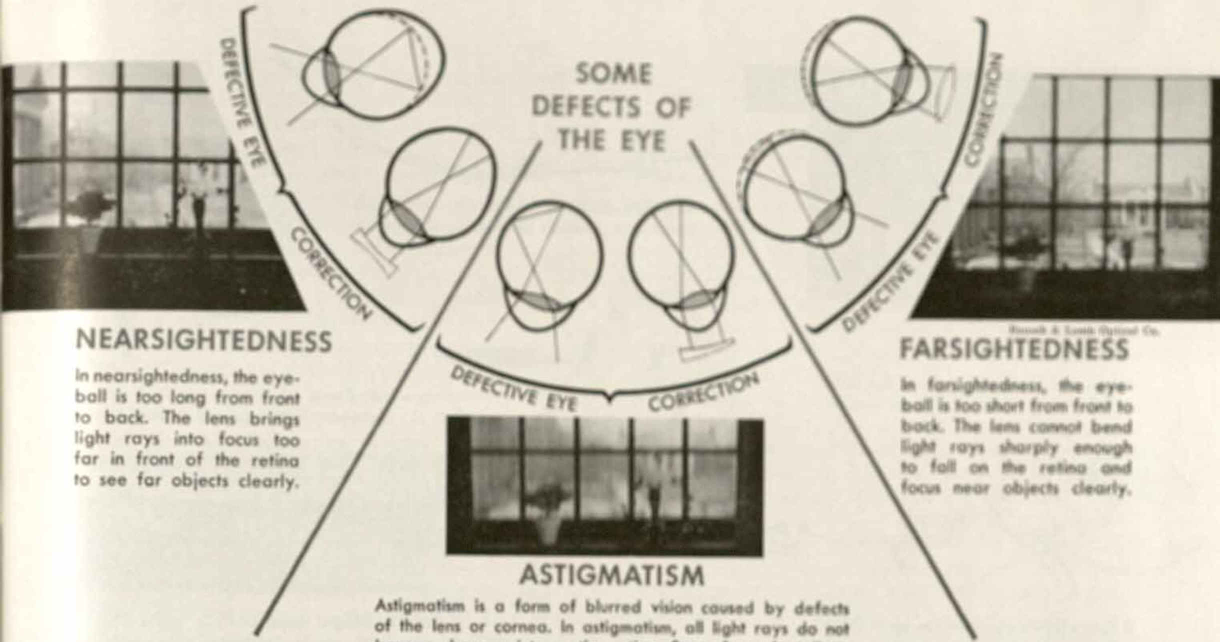

LENS
The Eye's Lens focuses the image on the retina.
The Camera's Lens focuses the image on a film.
LENS
IRIS OR DIAPHRAGM

The Iris opens and closes to allow just the right amount of light to enter the eye so that we can see sharply and clearly.

The Diaphragm of a camera can be set larger or smaller to allow enough light to fall on the film for a clear picture.







SOME DEFECTS OF THE EYE

NEARSIGHTEDNESS

In nearsightedness, the eyeball is too long from front to back. The lens brings light rays into focus too far in front of the retina to see far objects clearly.

Bausch & Lomb Optical Co.

FARSIGHTEDNESS

In farsightedness, the eyeball is too short from front to back. The lens cannot bend light rays sharply enough to fall on the retina and focus near objects clearly.

ASTIGMATISM

Astigmatism is a form of blurred vision caused by defects of the lens or cornea. In astigmatism, all light rays do not become sharp points on the retina. Some form short lines.

from your face. Close your left eye and look steadily at the left-hand dot. Move the paper slowly toward and away from your face. The right-hand dot will disappear when its image falls on the blind spot. See Blind Spot.

The pigmented cells of the retina behind the rods and cones absorb stray light. They prevent light from reflecting back and forth within the eye and causing blurred vision.

Day and Night Vision. The cones, which are sensitive only to good illumination, produce vision in moderate or bright light, such as daylight. The rods, which are sensitive to small amounts of light, produce vision in dim light, as at night. To demonstrate the importance of the rods in night vision, look at a star in the sky at night. When you look directly at the star, you will not see it clearly. The cones, at the center of the eye, are relatively insensitive to dim light. If you look slightly to the side of the star, it seems much brighter. In looking to the side, the star's image falls on the rods, which are most sensitive at night.

Dark Adaptation. You have probably noticed that when you suddenly go from a lighted room into a dark room, you can see almost nothing. But after a few minutes, objects in the room become dimly visible. Your vision continues to improve as your eyes become *dark adapted*, or accustomed to the dark. Dark adaptation results as the rods become increasingly sensitive. In the dark, chemical changes in the pigments of the rods increase their sensitivity. Complete dark adaptation usually takes 20 minutes or more. Before riding a bicycle or driving at night, you should give your eyes a chance to adapt to the darkness.

Light Adaptation is merely the absence of dark adaptation. When you have been in the dark for some time, even moderate light seems dazzling and painful. After a few minutes, the eyes become less sensitive. When light stimulates the eye, the rods lose the sensitivity gained in the darkness, and the cones become active. Normally, light adaptation takes only a few minutes.

Stereoscopic Vision, or the ability to judge depth, is well developed only in man and the higher animals. In man, the optic nerves from the two eyes fuse together at the *optic chiasma*, near the brain. From the optic chiasma, nerve fibers coming from the right half of each eye enter the right half of the brain. Fibers from the left half of each eye enter the left half of the brain. Each half of the brain receives an image from both eyes. The brain forms a single image from the images of the two eyes.

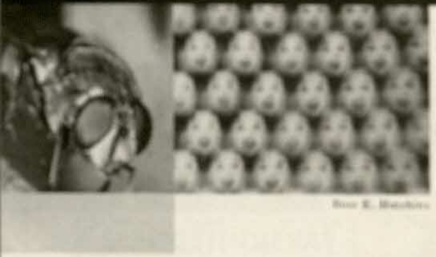
The ability of the brain to form a single image from overlapping fields of vision is called *binocular vision*. The slight differences between the image from the right eye and the image from the left eye give man stereoscopic vision.

You can demonstrate the importance of stereoscopic vision with a simple experiment. Have a friend hold a pencil straight up in the air about 2 feet in front of your face. Close one eye and hold one arm out from your side with the index finger extended. Slowly bring your arm around in front of you, and try to touch the tip of the pencil with the tip of your index finger. After a few attempts with one eye closed, find out how much more accurate you can be with both eyes open. This experiment shows why a one-eyed person does not have normal depth perception.

Eye Movement. In order to have proper binocular vision without *double vision*, or seeing two images, the image of an object must fall at corresponding points on each retina. The ocular muscles direct the eyes in such a way that this occurs. For example, in looking directly at an object, the image falls on the fovea centralis of each eye. Images that do not fall on corresponding points in the retinas are either seen as double or are ignored by the brain.

The *visual axis* of the eye is an imaginary line that extends from the object viewed through the cornea to the fovea. The muscles of the two eyes act together to keep the visual axes nearly parallel, or to bring them together at a particular point. When looking at a dis-

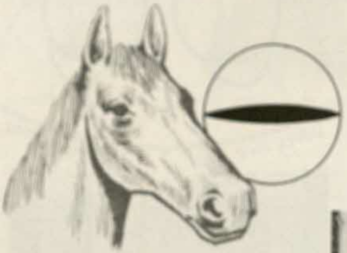
THE EYES OF ANIMALS


Ross E. Hutchins

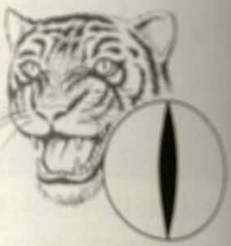
A Housefly's compound eye has over 4,000 lenses. Each forms an image.

A Crayfish's eye is made up of 2,400 parts. Each part is a separate eye.

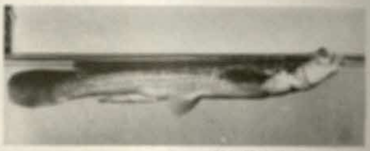
Whales cover their eyes with an oily solution that protects them from salt water.



A Horse's pupils are horizontal slits, allowing more vision from side to side.



A Cat's pupils are vertical slits, allowing better up and down vision.


New York Zoological Society

An Anableps' pupil has two parts. The upper part sees in air, the lower in water.

tant object, the axes of the eyes are almost parallel. In accommodation for near vision, the eyes *converge*, or turn toward each other. Their visual axes meet at the *fixation point*, a point on the object viewed. The image of the object at the fixation point falls on the fovea.

Most persons are either right-eyed or left-eyed, just as most persons are either right-handed or left-handed. To determine which is your *dominant eye*, hold a pencil vertically in front of you at eye level. With both eyes open, line up the tip of the pencil with a distant object. Close one eye at a time. Whichever eye is open when the pencil remains lined up with the object is the dominant eye. The eyes cannot focus on both the pencil and the distant object so that both images fall on corresponding points of the retina. When both eyes are open, the brain records the image seen by the dominant eye. It suppresses the part of the other image that does not fall on a corresponding point in the retina.

Persistence of Vision. The brain does not see a light until about a tenth of a second after the light is turned on. The image *persists*, or lasts, about a tenth of a second after the light is turned off. This persistence of the visual image explains why a glowing matchstick seems to leave a trail behind it when thrown away in the dark. A motion-picture projector throws about 24 still pictures on the screen in a second. But we see a continuous, smooth movement. Each picture on the screen is presented to the eye before the previous image in the brain fades out. Television also depends on persistence of vision. See MOTION PICTURE (How Motion Pictures Work); TELEVISION (Kinescope).

Changes in the Eye

Newborn babies have very blurred vision. Perhaps they can see only light and dark. Stereoscopic vision probably does not develop completely until a child is 6 or 7 years old.

Most white babies are born with blue eyes. A baby's eyes may begin to darken soon after birth. They usually become their true color in about six months, but sometimes it takes several years. Most babies of the Negroid and Mongoloid races are born with brown eyes, and their eyes remain brown. Heredity determines the permanent eye color.

As a person grows older, the lens of the eye becomes less elastic and loses its ability to change the focus. This gradual loss of accommodation is called *presbyopia*. Most persons become presbyopic at about the age of 45, and need glasses for reading.

Defects and Diseases of the Eye

Defects in the shape of the eye include *myopia*, or nearsightedness; *hyperopia*, or farsightedness; and *astigmatism*. They result from normal variations in shape, and are not considered diseases. Properly fitted glasses can compensate for these conditions.

Nearsightedness. A nearsighted person has eyeballs that are too long from front to back. The focus falls in front of the retina. Nearsighted persons can see close objects well, but have blurred vision for objects at a distance. See NEARSIGHTEDNESS.

Farsightedness. In farsightedness, the eyeball is too short and the focus falls behind the retina. A farsighted person has normal vision for distant objects. For near objects, accommodation can produce a clear image. But headache and eyestrain often result from the excessive accommodation that is necessary. See FARSIGHTEDNESS.

Astigmatism results from abnormalities in the shape of the cornea or the lens. Some light rays focus on the retina. But others focus in front or in back of the retina. This often results in eyestrain and blurring for both distant and nearby objects. See ASTIGMATISM.

Color Blindness, the inability to distinguish between certain colors, is an inherited defect of the eye. It cannot be cured. See COLOR BLINDNESS.

Strabismus, or cross-eyes, is a common defect in children. An imbalance in the action of the muscles that move the eyes causes one eye to turn in or out. To prevent double vision, the image produced by the eye that crosses is ignored by the brain. This may result in a permanent reduction or loss of vision in the crossed eye. Treatment of strabismus may require glasses, exercises, surgery, and covering the good eye to strengthen the weak one. See CROSS-EYE; SQUINT.

Diseases. Many diseases affect the eye. A *sty* is an infection of one of the tiny glands at the edges of the eyelids. *Conjunctivitis* is an inflammation of the conjunctiva. Common causes of conjunctivitis include infections, allergies, injuries, and chemical burns. A virus causes a type of conjunctivitis called *trachoma*. This disease ranks as the most common cause of blindness in Europe and Asia. *Pinkeye* is another type of conjunctivitis. *Iritis* is an inflammation of the iris. Allergy or infection elsewhere in the body may cause iritis. See CONJUNCTIVITIS; IRITIS; PINKEYE; STY; TRACHOMA.

Scarring of the cornea may result from injury or from infection. Surgeons can replace a scarred cornea with a normal cornea from another person in an operation called *corneal transplantation*. See EYE BANK.

The lens, which is normally transparent, may become milky and opaque in older persons. In this condition, called *cataract*, adequate light cannot reach the retina. Vision becomes progressively blurred. An operation to remove the lens, and the use of strong glasses or contact lenses, usually restores good vision. See CATARACT.

An increase of pressure inside the eyeball is called *glaucoma*. This pressure slowly destroys the optic nerve. If the pressure persists, blindness eventually results. See GLAUCOMA.

A diet that is deficient in vitamin A may result in *night blindness*. This vitamin deficiency damages the visual purple in the rods.

A sharp blow to the eye may knock the retina loose, so that it floats into the vitreous humor. Unless surgery is performed quickly, this *retinal detachment* causes permanent blindness.

Eyes of Animals

Animals Without Backbones. Most animals have organs of some kind that are sensitive to light. Even some one-celled protozoa, such as *Euglena*, have a colored eyespot that probably detects changes in light. Some many-celled invertebrates have special cells or clusters of cells that are sensitive to light. Others have more complex eyes. Insects have two kinds of eyes, simple and compound. *Simple* eyes react to light changes, but do not actually form images. *Compound* eyes, such as those of bees, may consist of many thousands of lenses joined together. These lenses can form images. The octopus has eyes that closely resemble those of man. But the layer of nerve cells lies behind, rather than in front of, the retina. The lobster has compound eyes that are set on the ends of jointed, movable stalks. See COMPOUND EYE.

Animals with Backbones have eyes generally similar to those of man. But they vary in many details. Many animals have a *tapetum lucidum*, or extra membrane behind the retina. This membrane acts as a mirror and reflects light rays back to the retina. It causes a cat's eyes to shine brightly in direct light. Because fish live in the water, they do not need tear glands or eyelids. Many land animals have a *nictitating membrane*, or third eyelid, for protection. It slides over the eye from the side nearest the nose.

The eyes of animals vary in size and shape. An eagle has a larger eye than a man has. An owl's eye is a third the size of its head. Fish and animals active in the dark have extra-large eyes, which help make up for the lack of light. Creatures that live in complete darkness, such as cave animals and fish that live at great depths, are usually blind. Their eyes may be greatly reduced in size. Perhaps the most unusual eyes are those of certain flatfish that lie on their sides at the bottom of the ocean. The eye that would be buried in the sand moves slowly toward the other eye during the fish's development. This allows both eyes of the adult fish to look up into the water. See ANIMAL (Animal Sense Organs); FLATFISH. JOHN R. McWILLIAMS

Related Articles in WORLD BOOK include:

DEFECTS AND DISEASES

Astigmatism
Blindness
Cataract
Color Blindness
Conjunctivitis
Cross-Eye
Farsightedness
Glaucoma
Iritis
Nearsightedness
Nystagmus
Ophthalmia
Optical Illusion
Pinkeye
Snow Blindness
Squint
Sty
Trachoma

UNCLASSIFIED

Animal (Animal Sense Organs;
picture, Unusual Eyes)
Blind Spot
Color (Color Vision)
Eye Bank
Glasses
Lens, Contact
Lighting
Ophthalmology
Ophthalmoscope
Optics
Optometry
Tears

Outline

I. Care of the Eye
  A. Preventing Eye Damage
  B. Using Your Eyes Properly
  C. Vision Tests
II. Parts of the Eye
  A. The Eyelids
  B. The Eyeball
III. How We See
  A. Focusing and Accommodation
  B. The Image on the Retina
  C. Day and Night Vision
  D. Stereoscopic Vision
  E. Eye Movement
  F. Persistence of Vision
IV. Changes in the Eye
V. Defects and Diseases of the Eye
  A. Defects
  B. Diseases
VI. Eyes of Animals
  A. Animals Without Backbones
  B. Animals with Backbones

Questions

Why can you see better at night if you do not look directly at an object?

What does it mean when someone has 20/20 vision?

What characteristic of the eye makes motion pictures and television possible?

Does the eye see things upside down? Explain.

How is the light entering the eye regulated?

What are the differences between nearsightedness and farsightedness?

What unusual animal has eyes that closely resemble man's?

What determines the color of the eye?

Through what parts of the eye does light pass on its way to the retina?

How long does it take your eyes to become adapted to darkness? Why does it take this long?

EYE BANK is a nonprofit agency through which eyes removed from both the living and the dead are distributed to specially trained surgeons. These surgeons perform an operation called *corneal transplantation* on persons who are blind from diseases that cause scarring of the *cornea*. This is the transparent outer layer through which light enters the eye (see Eye [The Eyeball]). The operation consists of replacing the central portion of the scarred cornea with clear corneal tissue taken from the eye of another person.

An eye remains suitable for surgery for only 72 hours after removal from the body. Because of this, it must be sped to the eye bank. After the death of a person who has asked that his eyes be donated for surgery, his nearest relative must give legal permission for removal of the eyes. A surgeon must remove the eyes within three hours after death, and pack them in special containers just above freezing temperature. The container is rushed to the nearest eye bank, where the eyes are carefully examined to determine if they are suitable for surgery. A qualified eye surgeon who has patients waiting for surgery is notified that an eye is available. The surgeon sends his patient to the hospital, and the operation is performed immediately after arrival of the eye.

The first eye bank was formed in 1945 in New York City. Many eye banks have since developed in other cities and countries. John R. McWilliams

See also Blindness.

EYEGLASSES. See Glasses.

EYEPIECE. See Microscope; Telescope.

EYETOOTH. See Teeth (Permanent Teeth).

EYRE, LAKE. See Lake Eyre.

EYRIE, *AIR ih*, or **AERIE,** *AY ih rih*, is the nest of a bird of prey, such as an eagle or hawk. These birds build their eyries in tall trees or on high cliffs. See also Eagle.

Ezra Read the Law of Moses to the Jews in Palestine.

Culver Service

From In Our Image by Houston Harte. © 1949 by Oxford University Press, New York

Ezekiel Was a Jewish Prophet of the Old Testament.

EZEKIEL, *ee ZEEK yul*, was a Jewish prophet who lived at the time when King Nebuchadnezzar carried many of the Jewish people into captivity in Babylonia. Before Jerusalem was destroyed in 586 B.C., Ezekiel repeatedly warned his people of their evil conduct, which he said was certain to bring ruin. But afterward, he encouraged the Jews with promises of a return to Palestine. An important teaching of Ezekiel was that the individual person, not just the nation, is important in religion. Walter G. Williams

EZRA was a Jewish priest and scholar trained in Jewish religious laws. Artaxerxes, King of Persia, sent him from Babylonia to Jerusalem to look after the Jewish people there. Scholars do not know definitely whether the king was Artaxerxes I or II. Thus, it is not known whether Ezra went to Jerusalem in 458 or 397 B.C. The story of his career is found in chapters 7 to 10 of the Old Testament book of Ezra, and in Nehemiah, chapters 8 and 9. They tell that Ezra read the laws of Moses to a great assembly in Jerusalem and had them accepted. Also, he stopped the Jews from marrying people of other nations.

The book of Ezra was at first combined with the book of Nehemiah and the book of Chronicles in a single book. But as we have it now, it begins with an account of King Cyrus freeing the Jews, who were captives in Babylonia. The story then is carried forward to the work of Ezra. Thus, it covers a period of about 80 to 140 years, depending on which date for Ezra is thought to be right. The author has used records that tell of the troubles between the Jews and their neighbors. He also drew on old family histories and some personal records of the work of Ezra. Clifton E. Olmstead